USING MANIPULATIVES AND VISUAL CUES WITH EXPLICIT VOCABULARY ENHANCEMENT FOR MATHEMATICS INSTRUCTION WITH GRADE THREE AND FOUR LOW ACHIEVERS IN BILINGUAL CLASSROOMS

A Dissertation

by

EDITH POSADAS GARCIA

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2004

Major Subject: Educational Psychology

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Approved as to style and content by:

Rafael Lara-Alecio (Co-chair of Committee)	Richard Parker (Co-chair of Committee)
Salvador Hector Ochoa (Member)	Robert Slater (Member)

Victor Willson
(Head of Department)

May 2004

Major Subject: Educational Psychology

ABSTRACT

Using Manipulatives and Visual Cues with Explicit Vocabulary

Enhancement for Mathematics Instruction with Grade Three and Four

Low Achievers in Bilingual Classrooms. (May 2004)

Edith Posadas Garcia, B.S., University of Texas-Pan American;

M.Ed., Prairie View A&M University

Co-Chairs of Advisory Committee: Dr. Rafael Lara-Alecio
Dr. Richard Parker

A study was conducted to assess the effects of two instructional strategies: manipulative-based instruction and visual cues in mathematics (both enhanced by explicit vocabulary enrichment) in a small group setting with young Hispanic students who are English language learners. The duration of the study was five weeks. Sixty-four third and fourth grade students were selected for participation based on their performance with problem solving items from the four release tests for 1999-2002 mathematics Texas Assessment of Academic Skills (TAAS) for third and fourth grades. A pre-assessment composed of 10 of the 13 TAAS objectives were administered. The four preselected objectives on which the students scored the lowest were identified for further instruction and assessment. The student population was limited to those of the original sixty-four achieving <55% overall on the pre-assessment. Following each week of instruction, a different assessment/probe was administered, for a total of 6 probes—including the initial pretest. For instruction, students were organized into three groups: 1) manipulative based instruction, 2) visual (drawings) cue instruction, and 3) no

additional mathematical instruction. The students in the three groups were of equivalent mathematical ability, and every effort was made to ensure the groups had the same number of students.

Pre-posttest improvement was measured with a mixed ANOVA (repeated measures, with a grouping factor), with instructional group as the grouping factor, and the pre/post assessment of math as the repeated measure. ANOVA results included non-significant progress for either grade level. Neither of the experimental groups in grades three or four showed significant improvement between the pre and post assessment.

Six sequential probes also were administered throughout the five-week study. A trend analysis for the three separate groups was conducted on the probe results to evaluate growth over time; trend analyses were conducted for each individual student and then averaged for each group. For the two experimental groups, the overall improvement at third and fourth grades was minimal. Overall, gradual improvement was noted, but the progress did not consistently occur from one week to another, and the improvement trend was not linear.

This dissertation is dedicated to all of you, who through God's grace, gave me the courage to nurture my dreams, to keep hope alive in spite of adversity, and persevere in the face of seemingly overwhelming obstacles.

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Someone once said that there is no limit to what you can accomplish, as long as you set your goals and remain true to your aspirations. This dissertation was accomplished with the help and support of many people:

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To the father of my children, who in sharing them with me provided the living embodiment of the children who inspired my search for knowledge.

To my father, Ismael Posadas, and my mother, Olga Garcia, who have made me who I am today. They instilled in me values, morals, character and the drive to succeed. But most importantly, they believed in me.

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CHAPTER I

INTRODUCTION

According to the US Census Bureau, by the year 2025, Hispanic Americans will account for 18 percent of the U.S. population. In 2000-2001 within Texas, 570,453 English language learners (ELL) were identified and served in bilingual and ESL programs (Texas Education Agency [TEA] PEIMS, 2001). As the Hispanic American student population increases in Texas, failure rates and low achievement rates also increase for these students. Achievement differences between language minority and language majority students have been documented (Cocking & Chipman, 1998). Language minority students tend to score lower than Caucasian students on standardized tests of mathematic achievement at all grade levels. As there is no evidence to suggest that the basic abilities of minority students are different from Caucasian students, researchers speculate that the differential performance may be due in part to differences in English proficiency and inequalities of a challenging curriculum (Cocking & Chipman, 1998; Mestre, 1988). Effective instructional strategies should specifically target the academic needs of Hispanic and struggling learners in mathematics.

The overall passing rate of Hispanics in mathematics in Texas grades three through five is 86.9%. However, the new statewide mathematics assessment being developed promises to be of greater complexity and require a more in depth level of critical

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This dissertation follows the style and format of the Bilingual Research Journal thinking than the current Texas Assessment of Knowledge and Skills (TAAS) (TEA, 2001). Additionally, large numbers of Hispanic students of all ages in Texas fail to demonstrate grade-level proficiency in solving word problems (Cawley, Parmar, Foley, Salmon, & Roy, 2001; National Assessment of Educational Progress, 1992). With the results of the proposed study I hope to contribute to the research base and to facilitate knowledge of effective instruction to teachers so they may deliver effective instruction to improve Hispanic students' achievement in mathematics.

Language proficiency also appears to be a contributing factor in problem solving: nationally, Hispanic American students' performance on word problems is generally 10-30% below that on comparable problems in numeric format (Carpenter, Corbitt, Kepner, Linquist, & Reys, 1980; Cummins, Kintsch, Reusser, & Weimer, 1988; Saxe, 1988; Noonan, 1990). English language learners' discrepancy between performance on verbal and numeric format problems strongly suggests that factors other than mathematical skills contribute to that failure (August & Hakuta, 1997; Cummins, Kintsch, Reusser, & Weimer, 1988; LeCelle-Peterson & Rivera, 1994; Zehler, Hopscotch, Fleischmann, & Greniuk, 1994). A number of studies have provided evidence for a significant, positive correlation between math achievement and verbal ability (Aiken, 1971; Cocking & Chipman, 1988). Also DeAvila and Duncan (1981) and Fernandez and Nielson (1986) found a significant relationship between Hispanics' English proficiency and their mathematic achievement. During the instructional component of the study, to minimize the effects of the students' limited English proficiency, instruction using manipulatives and visual cues was in English and Spanish. English language learners (ELL) tend to spend most of their time on the prerequisite basic skills such as computation and rarely have exposure to high-order mathematics skills such as problem solving (Schwartz, 1991; Secada & Carey, 1990; Stoloff, 1989). Research in England, Japan, China, and the United States supports the idea that mathematics instruction and student mathematics understanding will be more effective if manipulative and activities with visual cues are used (Canny, 1984; Clements & Battista, 1990; Deines, 1960; Driscoll 1981; Fennema, 1972, 1973; Skemp, 1987; Sugiyama, 1987; Suydam, 1984). Additionally, visual cues have been shown to amplify and explain images and facilitate recall of new knowledge and to create imagery during learning that is critical to memory processes. Without these two skills, recall of new knowledge and memory processes, students are unable to move from concrete operations to abstract concepts successfully (Shephard and Cooper, 1982; Mayer and Gallini, 1990).

Furthermore, ELL need the conceptual based vocabulary that permits them to focus on key words, to interpret the meaning of sentences presented in the lesson, and to continue the general language acquisition process by requiring them to interact with peers and discuss subject matter. Researchers like Markovits and Sowder (1994), Baroody (1987) and Silver, Kilpatrick and Schlesinger (1990) point out that if students are encouraged to explore numbers relations through discussion of their own invented strategies and those of their peers; their intuitive understanding of numbers and number relations would be used and strengthened. Through this interaction both grammar and vocabulary are developed, and this process promotes English acquisition in a context-embedded, cognitively demanding activity that further promotes their understanding of difficult and abstract concepts (Piskor, 1988, 1986). Caine and Caine (1994) propose that as educators we must assist students in their search for how to make sense of things. Van de Valle and Watkins (1993) suggest that little research has been done in effective teaching strategies in early grades.

Relevance of Study

The study examined how vocabulary, manipulatives, and visual cues integrated into a mathematics lesson affected students' problem solving skills in mathematics. There is evidence that ELLs' achievement improves with the use of hands-on teaching and testing, permitting hands-on manipulation of three dimensional props (Garcia, 1991; Tharp, 1989). Other researchers have confirmed the potential for manipulatives in mathematic instruction, but caution that manipulatives are commonly misused (Carpenter, Fennema, Fuson, Heibert, Human, Murray, Oliver, & Wearne, 1994). However, there is limited research that focuses specifically on the use of manipulatives with Hispanic English language learners.

Much research exists that validates the teaching and use of visualization skills to enhance learning. Mathematics can be taught and learned visually; communication does not necessarily refer exclusively to the spoken language. Visual communication in mathematics is especially important to language minority students or students having limited proficiency in English (Cummins, 1984). An important skill is that of spatial sense, for which students may need many and varied experiences with drawing and visualizing (National Council of Teachers of Mathematics, 1989). The term spatial sense identifies what has been labeled spatial visualization, visual imagery, visual skill, mental rotations and visual processes (Bishop, 1993; Davey & Holliday, 1992; Stanic & Owens, 1990).

Vocabulary development is critical for English language learners because we know that there is a strong relationship between vocabulary knowledge in English and academic achievement. Without the necessary vocabulary knowledge students do not recognize concepts already in their schema and failed to visualize accurately. Therefore, it is necessary that vocabulary is an integral part of the core instruction and for students to know the vocabulary in order to visualize the concept. A survey of recent second language acquisition research found that second language vocabulary knowledge is the single more important factor (of oral proficiency) for academic achievement (Saville-Troike, 1984). Basic proficiency is not adequate as language minority students do not have exposure to, or lack an understanding of, the content-specific vocabulary needed to perform the more demanding tasks required in academic courses (Short & Spanos, 1989). Ruddell (1997) found that when students are shown how to identify key content vocabulary they become adept at selecting and learning words they need to know. For example, if students were given a problem of multiplication that asks them to arrange 5 rows of baseball cards so that every row has 5 cards and then determine the total number of cards, they were unable to perform this task because they did not know the meaning of row. Because they couldn’t perform the task it seemed that they couldn’t perform the math concept; however, they might of known the math concept but not understand the vocabulary. Teachers must therefore pre-teach the vocabulary. Saville-Troike (1988, p.5) describes transfer as “a preexisting knowledge base for making inferences and predictions” or a “preexisting script for school”. Hakuta (1990) gives the example that “a child learning about velocity in Spanish should be able to transfer this knowledge to

English with out having to relearn the concepts as long as the relevant vocabulary (in English) is available."

In the present study two groups of students received vocabulary instruction prior to solving mathematical problems. Group I solved the problems using manipulatives and Group II solved the problems using visual cues. The students were administered five additional probes during the five weeks of the study to assess their improvement in problem solving. Later these students were assessed to compare their performance on a standardized math test—a version of the TAAS. A third group of students did not receive any type of instruction but simply took all of the assessments.

Purpose of the Study

The purpose of the present study was to measure the effectiveness of intensive small group instruction using three instructional strategies to improve Hispanic bilingual students' ability to solve mathematical problems. The setting of the study was third and fourth grade classrooms in a rural school district in Texas. The project measured the rate of improvement of a group of students who had high to low mathematical ability skills.

At the same time, the study examined the effectiveness of small group instruction of these students using vocabulary enrichment, manipulatives, and visual cues. The study was designed to extend the research into a previously unstudied area: effective mathematics instruction outside of the class with a small bilingual group composed of at risk students who are limited English proficient and possess limited English vocabulary.

Research Questions

This study addressed two research questions:

1. Based upon pre-post testing, which of two small-group interventions, emphasizing, a) Manipulatives or b) Visual Cues (and both emphasizing vocabulary enrichment) conducted four days a week for five weeks, most improves Hispanic English language learners' mastery of mathematical concepts in operation and problem solving, compared to their peers in the comparison group?
2. Based on progress monitoring probes, when compared to their peers in the comparison group, to what degree did members of the two experimental groups improve in mastery of mathematical concepts in operation and problem solving?

Definition of Terms

The terms used in the present study and their definitions follow:

Texas Assessment of Academic Skills (TAAS): A state standardized test administered at the end of the school year to assess student's mastery of skill in the following content areas: math, reading/writing, science, social studies. It is administered to third through twelfth grade students to assess the students' objectives and skill established in the state curriculum.

Texas Assessment of Knowledge and Skills (TAKS): A state level assessment that replaced the TAAS in 2002-2003 school year. It is administered to third through twelfth grade students to assess the students' objectives and skill established in the state mandated curriculum. Students are assessed in the following content areas: math, science, social studies and Reading/Writing.

Bilingual Education: An instructional setting in which instruction is conducted in two language: the native language of the student and English.

English Language Learners (ELL): A student whose native language is not English and the proficiency level in English is not considered sufficient by district and state criteria.

Oral Language Proficiency Test: An oral assessment that determines the English language proficiency level of students with a language other than English spoken at home. It designates three levels of fluency, non-English speaker (NES), limited English speaker (LES), fluent English speaker (FES).

CHAPTER II

REVIEW OF RELATED LITERATURE

Use of Manipulatives in Mathematics Instruction

Clements and McMillan (1996) state that concrete knowledge can be of two types: “sensory-concrete” which is demonstrated when student’s sensory materials to make sense of an idea; and “integrated concrete” which is built through learning. Integrated concrete thinking derives its strength from the combination of many separate ideas in an interconnected structure of knowledge. When children have this interconnected type of knowledge, the physical objects, the actions they performed on the objects and the abstractions they make are all interrelated in a strong mental structure. This is in line with the constructivist belief that students build their own knowledge; they do not receive knowledge prepackaged from others (Clements and McMillan, 1996).

In every decade since 1940, the National Council of Teachers of Mathematics (NCTM) has encouraged the use of manipulatives at all grade levels. Suydam and Higgins (1977), in a review of activity based mathematics learning K-8, determined that mathematic achievement increased when manipulatives were used. Sowell (1989) performed a meta-analysis of 60 studies to examine the effectiveness of manipulatives used in mathematics with kindergarten through postsecondary students. The consensus of these studies indicated that manipulatives could be effective; however, they also suggested that many teachers did not use manipulatives. Sowell also found that long term use of manipulatives was more effective than short term use. Even so, when manipulatives were used over an extended period of time, teachers' level of training critically influenced the effectiveness of manipulatives.

Researchers who examined the potential of manipulatives in mathematics instruction cautioned that manipulatives were not well used (Carpenter, Fennema, Fuson, Hiebert, Human, Murray, Oliver, & Wearne, 1994). Regardless of the innate appeal of using materials, investigations of the effectiveness of the use of concrete materials yielded mixed results (Benarz & Janvier, 1998; Bughardt, 1992; Hiebert, Wearne, & Taber, 1991; Thompson, J., 1992). P. Thompson (1994) suggested that the apparent contradictions in studies using manipulatives were probably due to aspects of instruction and students' engagement to which the studies did not pay close attention. Just using concrete material was not enough to guarantee success according to Baroody (1989). Yet, manipulatives could play a role in students' construction of meaningful ideas.

In Texas, Chapter 75 of current education law has stated that new concepts should be introduced with appropriate manipulatives at the elementary and secondary level (Peavler, DeValcourt, Montalto, & Hopkins, 1987). The new assessment in the state of Texas, named the Texas Assessments of Knowledge and Skills (TAKS), requires more rigorous standards than the prior assessment, the Texas Assessment of Academic Skills (TAAS). Students are expected to be actively involved in structured activities that develop understanding and enhance the ability to apply skills. Mastery at the concrete level is to be evaluated by the students' demonstrating use of manipulatives under TAKS. However, building concrete interpretations of math problems by using manipulatives does not by itself ensure student learning (Hiebert et al, 1991).

One measure of a student's knowledge in mathematics is the ability to explain why and how he/she processed the information to come to a solution (Markovits & Sowder, 1994, Baroody, 1987, Silver, Kilpatrick & Schlesinger, 1990). When a student explains or writes about the thinking related to the experience of solving the problem he is involved in metacognitive processes and thus understands his own learning. To be a good problem solver and be able to explain one's thinking, one must be proficient in the language of problem solving. The English language leraners may be at a disadvantage due to lack of accessibility in the second language rather than an inability to solve the problem (Mestre, 1981).

Many studies confirmed that young children, regardless of socio-economic background, possess considerable informal mathematical knowledge that they have gained through play, but which the curricula may fail to use this knowledge (Bell & Bell, 1988; Resnick, Lesgold, & Bill, 1990; Carpenter, Ansell, Franke, Fennema, & Weisbeck, 1993). For example, even without instruction, most kindergarten children are capable of solving a wide range of simple addition and subtraction story problems using their own inventive methods, often involving objects at hand (Riley, Greeno, & Heller, 1983; Carpenter and Moser, 1984). Multiplication, division, and fraction problems are also within their reach when manipulatives are available (Carpenter, Ansell, Franke, Fennema, & Weisbeck, 1993).

The need for increased use of manipulatives during instruction and self-initiated play or learning in schools was recognized before 1990 and educators continue to advocate using a variety of forms to represent mathematical ideas and concepts for students. Research findings (Suydam, 1984, 1986) and theoretical considerations (Hiebert, 1984, 1988; Lesh, Post, Behr, 1987) have supported the use of manipulatives in school. For example, when physical three dimensional objects are available, students experience mathematics as processes that demand thought, creativity and understanding (Davis, 1984). This is in sharp contrast to the limited learning that occurs when students participate only in seatwork on algorithms or procedures (Carpenter and Lehrer, 1999). The use of manipulatives in mathematics instruction has also been demonstrated by several other researchers.

Cramer, Post and DeLamas (2002) contrasted the achievement of students using either commercial curriculum (CC) for initial fraction learning with the achievement of students using the Rational Number Project (RNP) fraction curriculum. The RNP curriculum placed particular emphasis on the use of multiple physical models and translations within and between modes of representation—pictorial, manipulative, verbal, real-world, and symbolic. The instructional program lasted 28-30 days and involved over 1600 fourth and fifth graders in 66 classrooms. Students were randomly assigned to treatment groups. Students using RNP project materials had statistically higher mean scores on the posttest and retention test and on four of six subscales: concepts, order, transfer, and estimation. Interview data showed differences in the quality of students' thinking as they solved order and estimation tasks involving fractions. RNP students approached such tasks conceptually by building on their constructed mental images of fractions, whereas CC students relied more often on standard, often rote, procedures when solving identical fraction tasks. These results were consistent with earlier RNP experimental work with smaller numbers of students in several teaching settings.

Olkun’s (2003) study compared the effect of computer versus concrete manipulatives for the learning of two-dimensional geometry. Participants were 93 fourth and fifth grade students. A pretest, treatment, and posttest experimental design was used. The pre and posttest consisted of a paper and pencil test of 24 two dimensional geometry questions, designed by the researcher. There were three treatment groups: computer, concrete, and control. The computer groups solved computer-based tangrams; the concrete group solved wooden tangrams; the control group had no filler activity. Both the computer and concrete groups improved significantly, with the computer group improving slightly more. Fourth graders gained more in the concrete situation, while fifth graders benefited more from the computer manipulatives.

Shafer (1998) described a three-point plan to improve the mathematics scores of students at an elementary school in Texas. In investigating the causes for students' low scores, the school found that its mathematics curriculum was being followed only sporadically by teachers; its curriculum was not fully aligned with the Texas Assessment of Academic Skills; its teachers were not implementing effective strategies in mathematics instruction in a consistent manner; many of its teachers did not feel adequately prepared to teach mathematics effectively; and its mathematics instruction was in the traditional, textbook-driven, paper-and-pencil format. The plan required teachers to teach the objectives to be tested, use manipulatives and teach problem solving, and spend increased time teaching mathematics. Results indicated that the three-point plan worked. Mathematics scores showed a steady increase each year and the school wide math mastery score of 37.5 percent in 1993 rose to 84.1 percent by 1997.

Terry (1995) designed a study to assess the effectiveness of mathematics manipulatives and mathematics manipulative software use on students' computation skills and spatial sense. Three treatment groups were created--Mathematics Manipulative (MM), Mathematics Manipulative Software (MS), and Mathematics Manipulative with Mathematics Manipulative Software (BOTH). A three week unit was taught with focus on the development of computation skills: addition for grades two and three and multiplication for grades four and five. In addition, a one week unit was taught that focused on the development of spatial sense, specifically on the ability of the subjects to create layering models. Base Ten Blocks and attribute shapes, both in manipulative and manipulative software form, were utilized for the computation unit and spatial sense unit, respectively. A three way analysis of variance was used to interpret the data from the study. In four of the six ANOVAs for the computation unit there was a significant difference for the treatment group which used both; whereas, the spatial sense group had no significant statistical findings. Teachers reported a marked preference for software. They reported that it was easier to manage instruction, students were more on task with the software, and students were more motivated and excited when utilizing the software.

The overall findings of the four research studies discussed all yielded positive results and significant gains when manipulatives were used in the classroom. However, it is imperative that all teachers receive training on how to use the manipulatives effectively and enhance learning.

Use of Visuals and Drawings in Mathematics Instruction

Mathematics can be taught and learned visually; communication does not rely exclusively on spoken language. Visual communication in mathematics was found to be especially important to language minority students or students having limited proficiency in English (Cummins, 1984). Visual literacy must be taught in order to include visual abilities in problem solving.

Visual literacy has been defined as “the ability to read and understand that which is seen and the ability to generate materials that has to be seen to be understood” (Wileman, quoted in Seels, 1994, p.103). Furthermore, “visual literacy is the learned ability to interpret visual messages accurately and to create such messages” (Heinich, Molenda, & Russell, quoted in Seels, 1994. p. 104). In other words, “visual literacy is the ability to understand and use images, including the ability to think, learn, and express oneself in terms of images” (Braden & Hortin, quoted in Seels, 1994, p. 104). Just because we are able to see does not mean we are able to understand. We know that learning involves making connections and those connections depend upon what the individual brings to learning—prior knowledge and past experiences (Brooks & Brooks, 1993; Piaget, 1973).

Visual literacy occurs in the classroom when students translate concepts presented verbally into visual representations such as emphasis mapping, (McCagg & Dansereau, 1991), diagrams (Guri-Rozenblit, 1998), visual analogies/imagery (Smith & Ragan, 1992), visualization of numerical data (Tufte, 1983) and visual organizers—Venn diagrams, concept maps, chains, flow charts (Clark, 1991). These applications all encourage the use of cognitive strategies (West, Farmers, & Wolf, 1991), in any subject area, but especially in mathematics.

Although these instructional aides are in place in classrooms, teachers are not necessarily trained how to use them to their full potential. It was determined by Box and

Cochenour (1995) through a survey of teacher training programs that teachers had limited to no knowledge about implementation of these activities in the classroom. Since teachers did not teach these connections, the majority of students were unable to transfer what they learned in the classroom to mathematical applications in everyday math (Lave, 1988; Lave & Wenger, 1991 Kaput, 1994). For example, everyday situations may have involved multiple steps of problem solving, such as percentages and distance, but students were not able to visualize or draw the problem steps to facilitate understanding and problem solving.

However, English is a language of many shaded meanings which cause confusion to ELL. In mathematics, ‘line’ has a very specific meaning which differs from its meaning in home economics. In mathematics line is a noun meaning a row, column or stroke. However, to line in home economics is a verb meaning to coat. Furthermore, language minority students are often literal readers. Support for such learners can be enhanced by supplementing discussions and activities with pictures and visual supports (LaPlante, 1997) when students are exploring new mathematical concepts with new mathematical vocabulary. Without knowledge of the specific contextual meaning the ELL will not have automatized communicative tools. Visuals may make mathematics more comprehensible to those students who have limited language facility. The following are summaries of recent research demonstrating the use of visual cues in academic instruction:

Goins (2001) examined the effects that manipulatives had on the learning of algorithmic skills and understanding. His study specifically examined the effects of using algebra tiles on students' learning of polynomial multiplication. Whole class participation with rectangular tiles such as Lab Gear™, algebra tiles, and algeblocks were used as the manipulative teaching method. Visual teaching consisted of the use of pictures or graphs. Teacher demonstration without the use of any manipulative or picture setting was the non-visual/non-manipulative method of teaching. The class of the teachers who volunteered to participate was used as the accessible population sample. These consisted of Algebra I and Applied Math classes. Each class was a unit of analysis for the data. The classes were randomly assigned to the three methods of instruction. Teachers were given a curriculum with examples, illustrations, and worksheets for each lesson to be taught in the concept of multiplying positive polynomials.

All three treatments used the same or equivalent written examples and worksheets. The three methods of instruction were being implemented throughout South Carolina and the United States as illustrated in textbooks and research materials. These have become established and accepted methods of instruction. A statistically significant difference between the non-visual/non-manipulative and the manipulative teaching methods was found in both the skill data and the understanding data. This difference also extended to the open-ended question while asked students to explain the process of multiplying polynomials. The use of manipulatives had a positive effect in learning the algorithm of multiplying binomials and extending to the general situations of multiplying polynomials. The students who were taught using the manipulatives method were better able to explain the process of multiplying polynomials in a written paragraph. The use of manipulatives, pictures, and numbers and variables provided students with multiple representations of the concepts. Results showed that even through there was no statistically significant difference between the non-visual/non-manipulative and the visual methods, students using the visual method had a higher mean score in both skill and understanding and were better able to explain the process of multiplying polynomials.

Edens and Potter (2003) conducted a study to examine the conditions under which learner-generated illustrations serve as an instructional strategy promoting conceptual change. Specifically, the nature of students' misconceptions and the effects of student-generated descriptive drawings on conceptual understanding of scientific principles associated with the law of conservation of energy were studied. Students were randomly assigned to groups in which they copied an illustration, generated a drawing, or wrote a description about the principles. A statistically significant difference on a posttest conceptual understanding measure was found between students who generated descriptive drawings and those who wrote in a science log. Students who copied an illustration also scored higher than the writing group, but not at a significant level. Also, the quality and number of concept units present in the drawing/writing log were significantly correlated with posttest and delay test scores. Findings suggested that under certain conditions, descriptive drawing is a viable way for students to learn scientific concepts, a finding which supported the use of generative drawings as a conceptual change strategy.

Baker and Bielse (2001) investigated the types of experiences children should encounter to best understand the concept of average. Using a traditional approach with problem solving, a concrete approach with manipulatives, or a visual approach with computer spreadsheets, similar lessons on the arithmetic mean were taught to 22 children in grades 4-6, in three multiage groups. Differences among pretest, posttest, and interview performances suggest some advantage in the use of a visual instructional style. Continued gains in performance were found after 4 months without further instruction. An algorithmic-like definition of average corresponded to better long-term performance than less precise definitions. Collaborative deliberations resulted in positive implications for the researchers' teaching.

The overall findings of the previous three studies suggest that visual cues and using descriptive drawing to solve problems is a viable way for students to learn math and scientific concepts. Findings support the theory that mathematics can be taught and learned visually, and in some cases enhance students' performance.

Relationship between Mathematics and Language/Vocabulary Development

Mathematics, a discipline that deals with abstract entities, requires the ability to reason as a tool for understanding (Russell, 1999). The National Council of Teachers of Mathematics (NCTM, 1989) recommended students be afforded varied experiences pertaining to the far-reaching and increasing impact of mathematics in order to appreciate the significance of math in today's global and technical society. Mathematics proficiency requires a mastery of the specific language and organization of ideas in mathematics as well as a grasp of mathematical concepts (Boyd, 2000). Research demonstrates that mathematics is not a universal language (Ramirez, Corpus, Mather & Chiodo, 1994; Secada, 1983) and that students must master specific vocabulary and specialized terms.

Research has drawn attention to the importance of language in student performance on assessments in mathematics (Abedi, Lord, & Hofstetter, 1998; Abedi, Lord & Plummer, 1995; Garcia, 1991; Lepik, 1990). Since language facilitates the acquisition of new information as well as learning complex ideas and processes, open-ended questioning encourages the type of complexity encountered in thinking through mathematical concepts (Bodrova, & Leong, 1996). Many language educators and a growing number of mathematics educators argue that the nature of mathematical language impose a heavy burden on all students regardless of the language of instruction (Spanos, Rhodes, Dale & Crandall, 1988; Cuevas, 1984; Mestre, 1981). In addition, language seems to affect mathematics performance and marked difference in English and Spanish fluency is considered to be a contributor to Hispanic Americans' performance and involvement in mathematics (Valverde, 1984).

Students from linguistically diverse backgrounds usually arrive to school with a basic understanding of math concepts (Chamot & O'Malley, 1987; Cummins, 1989), yet ELL tend to score lower on standardized tests of mathematic achievement. There is no evidence to suggest that the basic mathematical abilities of ELL differs from non-ELL (Cocking & Chipman, 1988; Mestre, 1988), and the ELL are often misjudged as underachievers (Moss & Puma, 1995).

In short, to succeed in the mainstream classroom, ELL must learn both academic and communication skills in an environment where instruction is presented in a relevant and meaningful way that is appropriate for English language development skills (Secada, 1989). Underachievement for Hispanics students in mathematics is related to their limited English skills because assessment problems are presented in an abstract form that was very reliant on verbal/reading skills and on linear reasoning (Garcia, 1991; Tharp 1989). Review of studies on language and mathematics, (Aiken 1971, 1972) found significant correlations between reading ability and arithmetic problem-solving ability

Students, including ELL, must be taught in ways that allow them to experience the content as understandable (Carpenter and Lehrer, 1999; Goldsmith & Shifter, 1993). Further, evidence shows that ELL achievement improves with the use of hands-on teaching and tests which permit hands-on manipulation of three dimensional props (Garcia, 1991; Tharp, 1989). Similar levels of success occur when students conduct thoughtful investigations with their peers using appropriate materials in a supportive environment (Maher Martino, Davis, 1994).

In mathematics assessment situations, Khristy (1992) and Morgan (1998) argued that the learner needed to understand a particular math concept or procedure and also needed to understand and choose the thinking processes that lead to correctly resolving the problem. The difficulty was increased because the students did not heed directions, such as to explain and justify. They did not do so because they did not know what was meant by the mathematical directions (Dossey, Mullis, & Jones, 1993). The issue then becomes one of equity because students possessing linguistic skills associated with advantaged, literate backgrounds are more likely to display the appropriate operations than those from less advantaged backgrounds (Morgan, 1998).

One important aspect of reading and listening, comprehension is vocabulary. If a student has a higher level of vocabulary then reading and listening comprehension will usually also be higher. Therefore, the linguistic cues—the words and structure guiding processes and thinking—used in math lessons are significant to learning (Winograd & Higgins, 1995). To afford an equal opportunity for success to ELL in mathematics, the vocabulary of mathematics and general vocabulary must be deliberately and specifically taught. An alternative to this would be to change the language of the problems to the students' native language. Studies by Rothman and Cohen (1989) further supported the link between language and the vocabulary of mathematics. Ginsburg (1981) discovered that the vocabulary students have for expressing math and number concepts differed widely and changing the language of the problem to the student's native language raised student performance. To further demonstrate the relationship between mathematical ability and the development of vocabulary detailed summaries of relevant research were reviewed.

Abedi and Lord (2001) investigated the importance of language in student test performance on mathematics word problems. Students were given released items from the National Assessment of Educational Progress mathematics assessment, along with parallel items that were modified to reduce their linguistic complexity. In interviews, students typically preferred the revised items over the original counterparts. Paper-and-pencil tests containing original and revised items were administered to 1,174 8th grade students. Students who were ELL scored lower on the math tests than proficient speakers of English. Linguistic modification of test items resulted in significant differences in math performance; scores on the linguistically modified version were slightly higher. Some student groups benefited more from the linguistic modification of items—in particular, students in low-level and average math classes, but also ELL.

Folmer (2002) investigated the impact that direct instruction in strategic reading and problem solving would have on enhancing students' mathematical thinking processes when solving non-routine, text-based mathematical problems. As a result of the inclusion of such mathematical problem solving in the Pennsylvania State System of Assessment, it was necessary to consider the potential implications of this implementation on mathematics instruction, curriculum, and assessment as it occurred in the classroom. What realignment of mathematics instruction, curriculum, and assessment needed to occur in order to provide students with opportunities to integrate reading, problem solving, and mathematical thinking processes within the context of language-based problems?

The study examined the impact that direct instruction in strategic reading and problem solving have on enhancing students' mathematical thinking processes asked three research questions that were designed to examine the essential elements inherent in this topic. The first question investigated the potential for improving students' abilities to accurately solve language-based mathematics problems when provided with instruction in a framework of strategic thinking. The second question focused on how the use of reading and problem-solving strategies in language-based mathematics problems might be affected through direct instruction and meta-cognitive experiences. The third question explored how levels of confidence in approaching unique mathematical tasks might be developed when information is provided to support thinking. The study took place in a suburban, elementary school setting using two intact fourth grade classes (N = 48). The design was a quasi-experimental Pretest/Posttest Nonequivalent Peer Group. The independent variable was a 30-day intervention, in which reading and reasoning strategies needed for mathematical problem solving of text-based problems were taught. Dependent variables assessing solution accuracy, demonstrated strategy use, and perceived level of confidence were measured before and after the intervention for the experimental and control groups. The data was quantitatively and qualitatively analyzed. The quantitative results indicated that the application of reading strategies and the problem-solving process by the experimental group was statistically significant. Non-significant results were indicated in levels of accuracy in solving non-routine, text-based problems, except in the areas which examined discipline-related vocabulary.

Results indicated that providing students with a framework for the strategic use and application of specific reading and problem-solving strategies was beneficial metacognitively and in increasing students' levels of confidence.

Lager (2002) designed a study to investigate the language-mathematics interactions that hinder middle school ELL when responding to algebraic tasks about a linear pattern. Specifically, this investigation focused on how well students, both ELL and fluent English speakers (Non-ELL), understood task instructions, performed mathematically, and communicated their responses.

Two hundred twenty-one students from twenty classrooms in two low-performing southern California middle schools chose to participate. There was a 60/40 split between ELL and Non-ELL and a similar split between 6th graders and 8th graders. The majority of students were Latinos; almost all ELL were Spanish-speakers. Both quantitative and qualitative methods were used to gather and analyze data. All students engaged a mathematics activity centered on the development and multiple representations of a visually-based linear function.

The activity was comprised of nine related written tasks and made available both in English and Spanish. Students had to work silently, alone, and without notes. The investigator administered and evaluated the activity for all students. Soon thereafter, the investigator conducted one-on-one interviews with twenty-four of the students, encouraging them to explain their thinking in their own words.

The data were transcribed, coded, and analyzed for identifying language-mathematics interactions and exploring their composition. Many interactions were identified, explored, and catalogued within the mathematics register. However, other interactions necessitated calling for the addition of three new semantic categories to the Mathematics Register: words used to describe or define mathematical vocabulary, forms, and comparing the performance of non-ELL and ELL. The interactions found that some linguistic difficulties affected Non-ELL to a lesser degree (e.g. not recognizing "pattern"), some affected both groups to the same extent (e.g., misinterpreting Figure number ("n")), and a few affected non-ELL to a greater degree (e.g., double bar confusion). In terms of the number of correct responses to the tasks, there was an English proficiency effect, as non-ELL outperformed ELL. There was a smaller grade effect as 8th graders slightly outperformed 6^{th} graders. On average, non-ELL attempted more tasks than ELL, as they typically encountered fewer language difficulties.

Olexa (2001) addressed the interdependency of language development and academic progress by studying the relationships between language proficiency of children entering kindergarten and the reading, math, and written language achievement of those students as measured by standardized tests at fifth grade. A multiple regression analysis was used to examine the predictability of reading, math, and written language scores at the fifth grade by using preschool receptive and expressive language scores as predictor variables. An archival record study of 130 students was performed. The resulting correlations were positive and significant for all six experimental designs. The multiple regression equation was developed from the correlation results and used to predict reading, math, and written age scores. Receptive and expressive language were found to be valid predictive measures of reading, math and written language at the fifth grade.

Snyder (1994), in a cooperative learning situation examined the effects of manipulatives upon student ability to communicate mathematically. Previous research conducted in this area indicated that cooperative learning and manipulatives improved student ability to communicate mathematically. The objectives were based on The National Research Council entitled Everybody Counts: A Report to the Nation on the Future of Mathematics Education which states that the best way to learn mathematics is through discussion while working in groups. The ability to communicate mathematically was one of the major objectives stated by the National Council of Teachers of Mathematics in their Curriculum and Evaluation Standards for School Mathematics.

One of the best ways to develop effective language use is to encourage open discussion and honest criticism of ideas. Classroom activities were designed so that students were encouraged to express their ideas, both orally and in written form. Students worked cooperatively in small groups to solve problems and developed arguments to convincingly defend their approach amid conflicting ideas and strategies. A continuum related to student ability to communicate mathematically their understanding of concepts emerged.

When talking with children about mathematics and listening to their explanations of mathematical concepts, a wide range of responses were presented by students. The responses fell along a continuum, ranging from no knowledge or no response to complete understanding with the ability to communicate concepts correctly. Many students responded with answers which were characteristic of rote learning. They did not show complete understanding of the concepts being presented. Another group of students displayed understanding but did not use the vocabulary presented by the book. Teachers needed to listen to student answers in order to understand vocabulary which may vary from book vocabulary or explanations. Additional research was recommended to further investigate and identify other locations along the continuum.

Stephenson (2002) conducted a case study to compare the ways that language was used as a medium for social interaction, representation of experience, and as a tool for socialization in two fifth grade classrooms with contrasting approaches to mathematics. The follow-up, and then related language use to students' mathematical experiences and outcomes using sociocultural and sociolinguistics frameworks.

A combination of qualitative and quantitative methods captured data on multiple planes within each community: including observation and participation, videotaping and audio taping classroom interaction, collecting student work, teacher reflection and ratings of students, school and student background questionnaires, achievement testing, individual, paired, and group performance assessments, timed math facts tests, "think aloud" problem solving, and essays on "What is Math?" and "What is Social Studies?" In both classrooms, language was used as a medium for social interaction, representation of experience, and as a tool for socialization, in different ways and with different outcomes.

In the traditional classroom, social interaction was largely limited to teacher-directed Interaction-Response-Feedback sequences around tasks with low levels of cognitive demand. The opportunities for student participation, student choice, and narrative expressions of thought were minimal. In the open classroom, students had many opportunities to participate in a variety of interactions around high-level mathematical tasks, as well as to choose their activities, partners, and tools. Students from the two classes performed equally well on traditional mathematical tasks, but open classroom students outperformed the traditional on the more conceptual, open-ended, and social tasks. Open classroom students also had more productive interaction skills, used more conceptual problem solving strategies, and made linguistic choices that suggested that they had more diverse and connected views of mathematics than traditional students.

Participation in the open classroom also seemed to mitigate some of the effects of socialization in the broader community by gender, suggesting that differences may be more a function of context than the nature of either females or mathematics. The methodology and findings of this study had implications for future research on the role of language in mathematics education, and reform efforts in mathematics education in general.

Overall results from the previous studies discussed, measured the relationship between mathematical ability and the development of vocabulary, especially students with limited English proficiency, showed positive results and improved performance. Their mathematical skills improved by simply using linguistic modification of test items that resulted in significant differences in math performance.

Academic Achievement and Mathematic Ability of Bilingual Learners

With an increasingly culturally diverse and technological society, it is essential that all children be provided with equal opportunities to master the mathematical skills essential for social and economic success (Campbell, 1995; National Science Foundation, 1994; Rechin, 1994). The most urgent social issue affecting poor people, Hispanics, and other minorities is economic access, which is critically dependent upon mathematic literacy (Moses, 2001). A disproportionate number of Hispanics drop out of mathematics courses, denying themselves access to economic advancement through employment in the technical sector (Miller 1995; National Commission on Mathematics and Science Teaching for the 21st Century, 2000; National Science Foundation [NSF], 2000). Hence, students with negligible mathematics skills end up having access to only the lowest paying jobs (Moses, 2001) and continued inadequate education of Hispanics in math will exact a high economic toll for society (Pelavin & Kane, 1990).

The report to the nation given by the National Research Council in *Everybody Counts* (1989) shows a need to increase Hispanic involvement in mathematics at all levels; to not do so is to risk becoming a divided nation in which economic and political power will be beyond the reach of Hispanics. Barriers for Hispanics in mathematics are the same factors that cause attrition from formal schooling and can be traced to differences in educational process and language (Schuhmann, 1992). The problems with language are self-evident, but educators are not necessarily aware that the accepted educational process itself hindered these students.

Although minorities and Hispanics made up one third of high school seniors, only one in ten scored at the advanced level on the most recent National Assessment of Educational Progress (NAEP) mathematics tests (Johnston & Viadero, 2000). Hispanics scores lagged behind those of Whites in academic and mathematic skills as early as kindergarten (Johnston & Viadero, 2000). As a result of educators' perceptions that these students have limited cognitive mastery, English Language Learner (ELL) were vulnerable to the "Matthew effect" where low achieving students in primary and elementary school will likely do progressively worse as they continued in school

(Reynolds, 1989; Stanovich, 1986). Limited cognitive mastery was defined in terms of a students' lack of procedural and conditional knowledge. Procedural knowledge was the ability to recognize how to solve the problem; conditional knowledge was the ability to know under what conditions something should be done (Waxman et al, 1991; Gagne, 1985; Jones, Palinscar, Ogle, & Carr, 1987).

Research suggested that expectations set for students directly influence students' achievement in mathematics. In as many as a third of all classes, teacher behaviors sustain the poor performance of low achievers (Good & Biddle, 1988). The implications of this for ELL students is an overemphasis on remediation, which may lead to perceived notions of "learned helplessness" and ultimate denial of opportunities to learn higher-order thinking skills necessary for advancement in mathematics (Knapp & Shields, 1990; Lehr & Harris, 1988; Foster, 1989). Less than one percent of Hispanics achieved a level in mathematics advanced enough to demonstrate the problem-solving skills needed to work in algebra and geometry (Division of Research, Evaluation and Dissemination, Directorate of Education and Human Resources, 1992). Given these factors and the purpose of the current study other studies were reviewed that outlined the academic achievement and mathematical ability of bilingual learners in general.

Ainsa (1999) devised a math activity that initially utilized "m & m's"™ as manipulatives, and then progressed to computer software math activities that was piloted and evaluated in five early childhood classrooms. The observational data obtained in this study is useful to other classroom teachers and scholars. There were no significant differences between learning tasks, monolingual students vs. bilingual students, and manipulative (hands-off) activities vs. computer (hands-on) activities. The positive effect was that the project was a successful and different approach to learning for monolingual and bilingual children. The most rewarding aspects of the program, according to the children, were candy and computers. Both seem to be high on children's evaluation of fun and learning.

Baez (1997) examined Mexican-American children's self-concept and its relationship to their academic achievement while controlling for acculturation. Anglo students were used as comparisons. One hundred seventy-four fourth and fifth grade students from a large, southeastern Texas school district participated. The Piers-Harris Self-Concept Scale, the Norm-Referenced Assessment Program for Texas (NAPT) and the Children's Hispanic Background Scale were administered. Three hypotheses stated there would be no significant effect of ethnicity, gender or self-concept on reading, math and language achievement, with the effects of acculturation statistically controlled. Findings were not as expected. Results found significance in reading by ethnicity as well as in math by self-concept. Practical suggestions in practice and future research were provided.

Bresser (2003) developed strategies for developing the computational fluency of English-language learners. The strategies included asking questions and using prompts, giving students time to process questions and formulate responses before eliciting responses to questions, modifying teacher talk, recasting mathematical terms and ideas, posing problems with familiar contexts, connecting words and symbols, reducing the stress level in the classroom, encouraging students to describe the methods of other students, getting students to translate the strategies of others, and inviting students to consider a strategy before sharing it with a partner and then the class. The implementation of these strategies with second- and third-grade students is described. As soon as communication became the focus of mathematics class, however, students began to make progress in their mathematical thinking. This process did not come easily; it took time and did not happen merely because students were allowed to talk. The author's role as the teacher was to create a safe environment for expressing ideas, model mathematical talk, provide mathematics games for students to work on in small groups that encourage conversations, and moderate discussions to make sure that the talk was productive and focused on the mathematics.

Over time, the class became less resistant to the teacher's expectation that an explanation must accompany an answer to a mathematics problem. When facilitating productive talk during mathematics class, teachers helped ensure that emergent English speakers fully participated by structuring discussions in ways that provided access to students with varying linguistic expertise. By using prompts, asking questions, and encouraging mathematics conversations, teachers accomplished two valuable goals: English-language development and computational fluency.

Dermitzaki and Efklides (2002) examined the structure of cognitive, metacognitive and motivational factors that contribute to academic achievement, and whether the structure of these factors was different in the domains of school language and mathematics. The sample consisted of 512 7th, 9th and 11th grade students in a Greek city. The variables measured were students' performance in school language and math and their respective verbal and quantitative abilities. Metacognitive experiences regarding the tasks at hand as well as metacognitive strategy knowledge were also measured. Finally, 4 different aspects of students' academic self-concept in school language and math, as well as their motivational orientation towards learning were examined. Results of confirmatory factor analysis with the nested factor method confirmed the existence of distinct cognitive and metacognitive structures involving both general and task-specific factors. Affective factors were not explained by a common general structure representing affect. Finally, there were no differences in the structure of the above factors between the domains of language and mathematics.

Edwards (2003) researched whether students who worked in collaborative groups to solve mathematical problems would later be more adept at solving similar problems on their own. Data were obtained from 122 fifth and sixth grade students who were assigned to mixed-language, mixed-ability groups of three or four students. The results suggested that although many students in these five bilingual classrooms may have been able to benefit from the opportunity to work collaboratively to solve mathematics problems, and although the class as a whole showed a statistically significant increase on the written test, a number of the students could not gain maximum benefit from this setting. Clearly, simply placing students in groups—even groups that are heterogeneous in terms of mathematical ability and language—does not guarantee that all members will participate fully and have the opportunity to verbalize, and eventually internalize, powerful methods of problem solving. Possible suggestions for improving math achievement among mixed-language learners, including roles for collaborative problem solving in mathematics, could include a "summarizer" who restates the clues or problem, a recorder of information, a materials manager, a "checker" who tests to see if potential solutions fit all clues, and so on. It also may be useful to state clearly and reinforce the rules for working in small groups; for example, taking turns, listening to other students, and giving specific reasons for statements and suggestion, because these behaviors seem to be associated with greater increases in problem-solving ability. Another recommended change involved the language used in the groups. In the study, although clues and materials were available in Spanish, almost all the groups discussed their work in English and held some side conversations in Spanish. For students who are new to the English language, teachers might consider first creating groups that carry out discussions in the students' native language and then transitioning to mixed-language groups.

Himmele (2001) examined the impact of English language proficiency on students' performance and understanding of math concepts taught through Math Land®, a manipulatives-based math program that emphasized the 1989 NCTM math reform standards. The researcher was a participant observer in two multilingual classrooms and one native English speaking classroom, and interviewed 40 teachers and 63 students. While the development of higher order thinking skills was said to be an important purpose of the program, opportunities to develop these skills were lacking in two of the three classrooms.

Language proficiency played an important role in the way concepts were presented to students. Interview assessments were omitted from lessons because of the students' difficulty in verbally answering questions. Debriefing portions of the lessons were easy to omit, and only one of the three teachers observed (a multilingual teacher) consistently included this very important portion in her lessons.

Overall, students seemed to have a positive attitude towards math. The role of American culture was evident in the way that students were taught. The mode of instruction fostered individualism and competition. The role of teacher as authority was emphasized through the role of praise and teacher's expressed discomfort and ambivalence toward the philosophy of the math reform and that of the program used. Lack of language proficiency did present a challenge to teachers and did not prevent teachers from providing students with higher order thinking opportunities.

Wang and Goldscmidt (1999) hypothesized that immigrant students, especially those with English language learners (ELL), perform less well than native-born students do. The authors explored the hypothesis that the ELL and immigrant students are channeled by schools (or self-selected) into less demanding courses, thereby reducing their opportunity to master core subjects in the curriculum. Data were taken from a large urban school district in California to investigate the roles of opportunity to learn (OTL), language proficiency, and immigrant status on 2,443 middle school students' mathematics achievement and growth over 3 years. Using a multilevel growth model, the authors found that reduced OTL lead to performance shortfalls, suggesting promises for the relatively inexpensive approach of directing immigrant and ELL into more demanding and sequenced curriculum pathways to improve achievement.

Summary

A review of literature in the area of mathematical instruction with the use of manipulatives demonstrated that they can be successfully employed for most students. Specifically visuals and drawings seem to improve learning in the fields of science and mathematics. Several studies indicated a relationship between mathematical ability and the development of language and vocabulary. Finally there is evidence that the mathematical ability and the overall academic achievement of bilingual learners can be improved through the use of manipulatives, bilingual education strategies with specific consideration to culture and language.

CHAPTER III

METHODS

Context of Study and Sample

The district where the study took place is the second largest in total square miles in the Houston area, encompassing 328 square miles. It is a semi-rural/agricultural and currently undergoing rapid residential and commercial development. The population within the district is approximately 10,000 people with a total of seven campuses serving over 4,600 students in grades prekindergarten through twelve. Under the state accountability rating system, the district was rated as Acceptable, in other words the passing rate in every content area tested on the TAAS met the minimum of 70%.

The present study took place at two of the four elementary schools in the district. Prior to this year, fourth grade students attended a purely fourth grade campus. The third grade participants attended one of the two K-3 campuses. In 2002-2003, the year of the study, third and fourth grade students were housed on all four elementary campuses. The 4th grade only campus will became a K-4 campus and a new K-4 campus will be added. The other two campuses were change from K-3 to K-4, as well.

The district's overall passing rate in mathematics for 3rd and 4th grade on the 2002 TAAS was approximately 90%. The Texas Education Agency offers the TAAS in both English and Spanish for grades 3 through 6. Students take the Spanish version if they are recent immigrants and/or their Spanish literacy is higher than their English literacy. This was determined at a Language Proficiency Assessment Committee hearing. The district-wide Hispanics' passing rate on the English version of TAAS for 3rd grade was approximately 80% and for fourth grade 90%. In third grade 43% of ELL took the TAAS in Spanish in mathematics. In fourth grade 42% of ELL took the Spanish version of TAAS in mathematics, with low percentage of those students passing. The students taking the Spanish version of TAAS in 3rd had a passing rate of approximately 80% and in 4th grade 70%.

Students in fourth grade all attended one campus; therefore, the district and campus passing rate is the same. But third grade students attended two different campuses. At the campus that was used in this present study, third grade students' passing rate overall on the mathematics test was approximately 80%; of the Hispanic third graders taking the test in English the passing rate was 70%. Those taking it in Spanish achieved a passing rate of 80%. There is an obvious discrepancy in passing rates between the general population and the Hispanic population, whether or not they test in English.

Bilingual Education Program

The bilingual education program on the two elementary campuses ensured that ELL students learned English and would succeed academically in school. Students participating in these programs were provided linguistically appropriate instruction which was cognitively appropriate in that creativity, problem solving, and other thinking skills were cultivated in mathematics and other content areas. The district implemented a transitional bilingual program that provided a gradual progression from instruction in Spanish and English to instruction solely in English. Every grade level, beginning in Pre-K, used a ratio of instruction in English and Spanish. In third grade it was 50% Spanish and 50% English; in fourth grade it was 60% English and 40% Spanish. In other words, three of the six hours of instruction in third grade were in Spanish and in fourth grade two hours of the six were in Spanish.

The schools in this district served bilingual students in grades Pre-K through four who had been identified as English language learners (ELL) in accordance with state identification and assessment requirements (19 TAC §89.1225). The curriculum taught was the standard Texas Essential Knowledge and Skills (TEKS) —the state curriculum—which had adaptations for students acquiring a second language. Therefore, the only significant difference between the two curricula (standard and adapted) was the language of instruction. Students were served in a self contained bilingual classroom where the bilingual teacher taught all the content areas.

Participants

Participants in this study were sixty-four students in grades three and four, male and female, ages 9 through 11 who were in a bilingual program. Some participants were first generation immigrants from Latin America, especially Mexico, with only 3% from Central America. Spanish was the primary language most often spoken at home; the majority of the parents were non-English speakers, other had limited literacy in their first language. All parents were employed jobs that entailed agricultural. All of the third and fourth grade ELLs were identified as economically disadvantaged and participate in the free and reduced lunch program that the district offered.

Students were selected to participate in the present study based on the overall score of the pre-assessment. Students who showed a deficit in mathematical skill based on results from the pre-assessment that ranged a score of 0% to 55% were included as participants. A fourth group of students were created, comprised of students who score at 56% or higher. This group participated only in the pre and post assessment parts of the study so that they would not feel totally left out. This additional data also allowed for further comparison between groups.

Instrumentation

This study used two sets of instruments which mathematical items were derived from the 1999-2002 TAAS release tests: a) a pre/post math assessment; and b) a series of 4 weekly math probes.

Pre/Post-Assessment Instrument

The assessment items in the pre- and post-assessment were taken directly from the original test items in the third and fourth grade TAAS tests that were administered in the spring of 1999-2002. A committee of mathematics specialists and teachers selected the items and objectives for the pre/post assessment. They were selected based on the criteria that they must readily lend themselves to working with manipulatives and visual cues. Each of the selected objectives was represented by two word problems on the pre/post assessment; there were a total of twenty items.

Consistency of question level and content was controlled. The pre and post assessments were developed at the same time, using essentially the same questions, but changed only the numerical representations and names in the word problems. The pre- and post assessments were created in English and Spanish to eliminate language as a barrier to improvement. The focus was solely on the understanding and learning of the mathematical concept/objective that was taught. The post-assessment measured the overall improvement of the participants and non-participants from the instructional phase of the study in order to yield an improvement comparison. Items on all probes were sequenced using TAAS mathematics objectives 8, 9, 10, and 11 in that order.

The pre-assessment was administered in both English and Spanish so that the researcher could identify students with low mathematical skills, whether they were English or Spanish speakers. During the English version administration, questions were read to the students by the researcher. When students completed the test, it was administered again, this time it was read to them in Spanish. They were given approximately three to four minutes to complete each question. Each question was read twice and participants responded in a written form using a supply-type response format which required that they create rather than choose an answer. This format also allowed them to show their work and processes that the used to solve the word problem. For the four probes and the post assessments, students were able to choose the language in which they preferred to take the test. Thus, the post-assessment had the same level of difficulty and format as the pre-assessment.

Mini-Probes

The purpose of the four equivalent mini-probes was to measure weekly improvement over the five week duration of the study. The researcher administered a mini-probe once every Friday after students had four days of instruction. The mini-probes contained twelve word problems that assessed a total of four objectives; all items were obtained from the 1999-2002 TAAS third and fourth grade mathematics release tests. Three items per objective on all of the mini-probes were provided in English and Spanish. There were insufficient original items from the released TAAS so additional items were created. To maintain consistency with the TAAS test, only minor changes were made:

the names and numbers within the items. All problems had the same format and difficulty level. All items were word problems which required participants to use problem solving skills and supply their answers in writing. The test was read to students in their language of choice with each question read twice. Participants were given three to four minutes to answer each item. Items were scored 0/1 for accuracy, yielding summative percent correct scores for each student per objective.

Test Construction

The instruments that were used in the present study were compiled from the third and fourth grade release TAAS tests for the years 1999-2002. The study was composed of a total of six probes that include a pre- and post-assessment, each comprised of twenty items, and four mini-probes, each comprised of twelve items.

The two sets of test instruments—pre/post assessment and mini-probes—that were used in the present study were created from the content universe that was developed by the Texas Education Agency (TEA) for the Texas Assessment of Academic Skills (TAAS) in mathematics for grades three and four. In 1981 the TEA defined the skills and objectives that were to be part of the curriculum framework: the Essential Elements (EEs). TEA undertook a rigorous process in which they integrated the input of content area teachers — in this case mathematics and science teachers — school administrators, parents, business people, and members of the general public in order to write the EEs. This curriculum framework established what students should learn. Using a similar process including field testing for reliability, the state also developed a series of assessment instruments to measure student achievement. The alignment between the EEs and these tests, first the Texas Assessment of Basic Skills (TABS), then the Texas

Educational Assessment of Minimum Skills (TEAMS), and finally the Texas Assessment of Academic Skills (TAAS) was inadequate. In July 1997 the State Board of Education adopted the Texas Essential Knowledge and Skills, new more specific curriculum, for implementation in September 1998. The alignment between TEKS and TAAS was better but still not total.

The Texas Education Agency (TEA) provides a representative form of each assessment instrument under the Texas Education Code, Chapter 39, and Subchapter B, which is made available periodically for public review and for formative student evaluations by school districts. These are called released tests.

The items of the two sets of instruments used in this study were sequenced and constructed using the same objectives, length, content, presentation format and response format. Students in grade three and four were randomly selected to be administered either Form A or Form B.

An item analysis was conducted to determine which objectives from each release TAAS year had the lower percentage passing. Table 1 illustrates an example, objective 8 from the 1999 released test, as shown below, may not be represented because it had a high passing percentage. A question representing the same objective but from the 2002 released TAAS was used because it had a more complex questioning structure, which students found to be more difficult.

Table 1

Comparison of Difficulty Level for the Same Objective

Objective 8 in Released TAAS 1999 Item #39	Objective 8 Released TAAS 2002 Item #40
A piece of paper was folded into two parts. Jorge drew six stars in each part. Which picture shows how many stars Jorge drew? Mark your answer. (Visual representation)	Jennifer bought 8 packages of donuts. Each package had six donuts. How many donuts did Jennifer buy in all? Mark you answer. (No visual representation)

The administration of the assessment followed a standardized format developed by the researcher to ensure a consistent routine. Testing took place at the same time, and location, with a consistent ambience. Sitting was pre-arranged and the specific instructions were given orally at every administration.

Instrument Validity

Face Validity

Face validity involves a casual and subjective inspection of the test items to judge whether they cover the content that the test purports to measure (Nevo, 1985). The instruments were reviewed by two bilingual teachers to determine whether they believe the test was measuring what it was intended to measure. They were asked if the type of mathematical items that were used in the assessment instruments in the present study represented the type of assessment they used to measure learning in their classroom. Teachers agreed that the items used to measure student improvement looked similar if not identical to the state assessment, TAAS. They agreed that these items were also the same type of question in the same identical format that they used to prepare their students for the TAAS test.

Content Validity

From the third and fourth grade mathematics TEKS, three mathematical domains were represented on the TAAS test. The mathematical domains: Concepts; Operations; and Problem Solving encompassed specific objectives and skills from the TEKS that students needed in order to master and apply. Thus, the TAAS represents a more comprehensive assessment of the state mandated curriculum.

The test items for TAAS were validated by TEA for their match with the state curriculum and the objectives of the Texas Essential Knowledge and Skills (TEKS). During the lesson planning phase of the study the actual TEKS which match the TAAS objectives will be incorporated in instruction and the assessment format will match TAAS. As explained before, content validity was supported by sampling items from an item universe of third and fourth grade released TAAS tests that were developed by TEA. Content validity will be ensured by systematically and sequentially presenting concepts to the students prior to initiating assessment of those concepts.

It had been established by TEA using the annual Texas Learning Index. The Texas Learning Index, or TLI, is a score that describes how far a student's performance is above or below the passing standard. The TLI is provided for the TAAS mathematics tests at Grades three and four. The TLI was developed to allow students, parents, and schools both to relate student performance to a passing standard and to compare student performance from year to year.

Table 2(below) represents the objectives from the TAAS tests for 1999 and 2002 which address the three test domains of mathematical concepts, operations, and problem solving as set forth by TEA. The researcher assessed the participants' level of mathematical ability in a pre-assessment that represented each of the objectives on the table with two problems per objective for a total of twenty items. Those objectives on which the participants demonstrated a high failure rate were used for the main body of the study—in the mini-probes; the post-test followed the format, sequence, and content of the pre-assessment. The ten objectives in Table 2 were derived from the three mathematical domains that were compatible with the use of manipulatives and visual cues for instruction. The average score per group/per student was displayed in a time series graphic representation.

Table 2

TAAS Mathematical Objectives Used in the Study

Domain	Objective	Description
Domain I Concepts	3	The student will demonstrate an understanding of geometric properties and relationships
Domain I Concepts	4	The student will demonstrate an understanding of measurement concepts using metric and customary units.
Domain 2 Operations	6	The students will use the operation of addition to solve problems.
Domain 2 Operations	7	The students will use the operation of subtraction to solve problems
Domain 2 Operations	8	The students will use the operation of multiplication to solve problems.
Domain 2 Operations	9	The students will use the operation of division to solve problems.
Domain 3 Problem Solving	10	The student will estimate solutions to a problem situation.
Domain 3 Problem Solving	11	The student will determine solution strategies and will analyze or solve problems
Domain 3 Problem Solving	12	The students will express or solve problems using mathematical representation.
Domain 3 Problem Solving	13	The students will evaluate the reasonableness of a solution to a problem situation

The released TAAS tests did not provide enough sample items to compile the four mini- probes. Additional items were created with changes only to the name of the person and the quantity in the word problem whenever possible. If the quantity in the word problem was a single digit the new item maintained that same structure. If the original question required carrying, borrowing, or regrouping, this was also maintained in the created question. Table 3 shows an example of an original TAAS question from 2002 3rd grade release TAAS test and a question created to add to one of the four mini-probes.

Table 3

Comparison of Original TAAS Question with Created Question

Original Item from Release TAAS test 2002 Objective 10, item #26 on Release TAAS	Question created using release TAAS Item #3 on mini-assessment #1
A spelling book contains 88 pages. A math book contains 203 pages. Which is the best estimate of how many fewer pages the spelling book has than the Math book has? Write your answer.	A grammar book contains 66 pages. A math book contains 302 pages. What is the best estimate of how many fewer pages the grammar book has than the Math book has? Write your answer.

The mini-probes consisted of four objectives that showed a high percent of student failures. Each probe contained twelve problems; each objective from released TAAS was represented by three problems on the probe.

The mini-probes were comprised of the 1999-2002 sample items from the released TAAS tests. The release TAAS years were chosen based on the results of an item analysis of the pretest results to determine the items with the highest failure rate. The item difficulty index will be in the range of 0% to 20%. If, in any given test year, an item did not present a high level of difficulty for the students, it was not be used. Because of insufficient items and the different question structures from the released TAAS, questions will need to be created for the mini-probes.

Internal Consistency (Reliability)

Internal consistency is an estimate of the average intercorrelation of all items on a test (or subtest), i.e. the extent to which they all measure the same skill (Gall, Borg, and Gall, 1996). Internal consistency was assessed to measure whether all items represented the same mathematical domain. The pre/post probes represented three domains and at least 6 items per domain. The four mini probes represented two domains in which six items are represented per domain. For each of the six probes, Cronbach's Alpha was calculated for the entire test. Given the small number of items (6) per domain, Alpha was not expected to be large, but should be at least .65 (Carmines, 1990). Alpha for the entire test should be at least .80 in order to have a reasonable level of reliability and determine if they indeed measure those mathematical skills (Carmines, 1990). The results will be presented in the Results chapter of the present study.

Other Data Collection

Multiple forms of data, e.g. attendance rosters, student work samples, student questionnaires, were gathered during and after the study. The data collection sources that were used are described below.

Oral Language Proficiency Test (*OLPT)*—was provided in both English and Spanish to measure the students' level of language proficiency. Three levels of fluency are described for both languages in speaking and thinking. They are applied to non-English speaker (NES), limited English speaker (LES), fluent English speaker (FES) and non-Spanish speaker (NSS), limited Spanish speaker (LSS) and fluent Spanish speaker (FSS). The OLPT is a widely used test and it has been nationally norm-referenced.

Lesson plans —Lesson plans were created to ensure the consistency of the instructional strategies being implemented. The objectives were taught in the following weekly sequence:

- Monday — Objective 8 — use of the operation of Multiplication to solve problems
- Tuesday — Objective 9 — use of the operation of Division to solve problems
- Wednesday — Objective 10 — Estimate solution to a problem situation
- Thursday — Objective 11 — Determine solution strategies and analyze or solve problems

Attendance Rosters — Attendance rosters were created to monitor daily attendance of all participants and non participants to document that all have equal opportunity and exposure to the instructional interventions. All absences were documented to provide additional explanations of results. There were two students that were absent in the five week duration of the study.

Interventions

Instruction

Participants were instructed in a small group setting using two instructional strategies that utilized manipulatives and visual cues and had vocabulary enrichment embedded as part of the lesson. Research and theorists stress the importance of natural language, concrete, physical or mental visual images (including pictures, graphs, and diagrams) and symbols in representing mathematical ideas (Lesh, Post, & Behr, 1987; Silver, 1987; Hiebert, 1988). Instruction required each participant to actively participate and work with the others in the group.

Explicit scripted lesson plans were followed daily and included vocabulary for students, materials needed the process as guided practice, and finally independent practice. For example, when objective 9 was taught (the use of the operation of division to solve problems) the teacher/researcher pre-selected vocabulary from the questions which potentially are a stumbling block for students. The words were selected based on students' lack of background knowledge or prior experience with the term. Usually the words were nouns. For example, Spanish speaking students did not recognize the word row as meaning a line of like objects. The teacher taught the word using the students' prior knowledge of how corn is planted in rows. This concept was readily accessible to them because of their agricultural backgrounds.

Once the vocabulary was understood by the participants, the teacher/researcher moved on to the guided practice stage of the lesson. Once participants demonstrated understanding of both vocabulary and process of using manipulative or visual cues, they were given a new version of the same problem, with different numbers, to solve independently or with a partner. Teacher/researcher monitored for understanding as the students work independently or with a partner.

Once the mathematical objective was clearly understood students had the opportunity for independent practice using different daily practice problems along with manipulatives or visual cues to solve the problem. Materials varied depending on the activity for the day. Vocabulary was always a part of the lesson process, as words were introduced and clarified to increase student's comprehension; it facilitated the solving of story problems.

Research Design

The present study utilized two separate designs, a pre-post comparison group design, and a time series design. Together, the two designs included four groups with a total of sixty-four third and fourth grade bilingual students.

Pre-Post Comparison Group Design

The pre-post design included four groups which received different interventions: (a) instruction with the researcher using manipulatives, (b) instruction with the researcher using visual cues, (c) a control group with the classroom teacher using traditional instruction, and or (d) a group with the regular classroom teacher which participated in only the pre and post probes, not the mini-probes. Each group had an equal number of students. All four groups received a pre and post assessment but the manipulative, visual cues, and control group also received the mini-probes.

Time Series Design

The study encompassed a five-week phase including 6 probes: the pre-assessment occurred at the beginning; four mini-assessments were administered, one per week; and the post assessment occurred at the end of week five.

Procedure

The following steps were taken to implement the pre-posttest control group and the time series design:

1. Equivalent groups were created, based both on random assignment and then on adjusting by matched pairs on the basis of pretest skill levels.
    - The practice of using a pretest to assist the randomization enabled the researcher to form matched pairs of low scores within the range of 0% to 55% passing.
    - The pretest yielded a percentage score that will be used to determine group placement and participation.
2. The pretest and posttest was administered to all groups at the same time, and the four mini probes at periodic equal intervals during a five week period.
3. Administered twenty-five minute small group mathematics instruction, except to the control groups, over the five week duration of the study.
4. Created logs for the home room teacher for scheduling purposes.
    - Teachers were asked to make adjustments in their schedule to accommodate the supplemental instruction.

- Supplemental instruction schedules were coordinated to ensure that students do not miss any classroom teacher instruction during their math time.
- A consistent time and schedule were kept throughout the five-week study.
- This ensured that the standardized procedure was followed throughout the study.

Internal Validity of the Design

The internal validity of an experiment is the extent to which extraneous variables have been controlled by the researcher, so that any observed effect can be attributed solely to the treatment variable (Gall, Borg, and Gall, 1996). The researcher was able to measure and observe improvement in the small group setting using the interventions. Using the complex design, as displayed above, that includes the pretest-posttest comparison group in addition to a time series design, can effectively strengthen internal validity.

The comparison group may control for the potential threats to internal validity as originally identified by Campbell and Stanley (1963): history, maturation and testing, instrumentation, statistical regression, selection, and mortality. The threat of history was reduced by eliminating several sources of bias: the teacher-researcher and time of day was consistent, and the instructional component of the study was conducted every school day without interruption for a five-week period. Also participants were randomly selected to participate in all three groups that include a comparison group.

Maturation and testing were controlled in that the total time covered by the study is five weeks—not short enough to be influenced by student memorization of items, but not so long that students' physiological maturation would be a factor. Also, the two treatment groups were compared to the comparison group to examine any changes. Instrumentation was controlled because conditions for intrasession history existed by using multiple judges, on several occasions, to observe the fidelity of implementation of instruction.

Statistical regression was intended to be avoided by equivalently creating groups based on low performance (0 to 55% accuracy) on the pretest and by comparing scores to the comparison group. The participants were grouped by randomly selecting them into each of the three groups. This was followed by a post-hoc matching to ensure equivalency. Selection threat was controlled for through randomization: the pre-test scores were compared to assure initial equivalence of groups. The threat of mortality was examined through attendance rosters for treatment groups and then separately for the comparison group.

Internal validity was strengthened through three elements:

Multi-group Comparison Including a Comparison or Control Group—The multi-group comparison enabled the researcher to make strong inferences about the effectiveness of the proposed study. If extraneous variables have brought about changes between the pretest and posttest, these should be reflected in the scores of the control groups. Thus, the change between the groups receiving small group instruction and the control or comparison group can be attributed to the intervention, with a fair degree of certainty.

Equivalent Groups——In order to improve logical inferences from the results, equivalent groups were formed by matching on the pretest results, from randomized student lists. Randomization with post-matching for balance is superior to pure randomization with small numbers of subjects. Students with similar scores were matched and then randomly re-assigned to treatment groups to make the groups as equivalent as possible.

Pre-Post, Time Series Measurement——The pre-post design coupled with time series measurement allows for a strong design. The pretest was used to select students for participation, to ensure that the groups were equivalent, and to check the gains made during study. The posttest will was used to compare significant gains. In a parallel design, time series measures were conducted throughout the study to judge improvement trends. Four probes were administered during the five week study, at one week intervals.

Generalizability

Given that the complex pre-posttest control or comparison group with a time series design had strong internal validity, the findings from the study permitted the researcher to draw conclusions about the effectiveness with other third and fourth grade students. The following elements were important in permitting the study to have strong generalizability: the type of participants, the generality of the mathematical content, and the practicability of the intervention.

The selected participants in this study were third and fourth grade bilingual students. They were Hispanic, primarily of Mexican descent, and were considered to be economically disadvantaged in accordance with state law. Their parents had a limited education and did not speak English. Participants were experiencing the transition between Spanish to English in their classroom instruction. All students had been in the United States for at least three years. This population was typical of that found in a

Texas public school third and/or fourth grade multiethnic classroom and yielded strong generalizability.

The mathematical content taught during the intervention for skills was drawn directly from the state curriculum and national mathematical basals**:** multiplication, division, estimation, and problem solving strategies. All were incorporated in any national mathematical textbook series or curriculum. The assessment probes required students to demonstrate the mathematical skills mentioned. Since Texas is a leader in influencing textbook writing, the Texas (and California) curriculum becomes, to a large degree, the national curriculum. Thus, this study contains high generalizability according to its instructional content.

The interventions in the present study consisted of two instructional techniques to facilitate learning: vocabulary enrichment using manipulatives and visual cues. These instructional techniques were implemented in a small group setting with a maximum of four students per group. Teachers in a classroom setting can easily group students by ability to target instruction. The manipulatives used are inexpensive and usually are constructed with simple material such as buttons, paper money, and teacher made clocks. Training with the manipulatives is of critical importance when instructing students with a variety of academic levels. The three interventions used: vocabulary enrichment, manipulatives, and visual cues are part of best practices in all instruction and, thus, enhance the generalizability of this study.

Internal Consistency (Reliability)

Internal Consistency, a form of reliability, was calculated on the mini-probes using Cronbach's Alpha**.** There were twelve items covering two mathematical domains

(Operations and Problem Solving); each domain contained two objectives and each objective will have three word problem questions. Item analysis was conducted on each separate mathematical domain on all of the six probes used through out the study.

Alternate Form Reliability

Another analysis that was calculated is the standard error of the slope across the six probes to determine how much alternate form reliability there is in the probes. It was calculated both individually for every participant and as a group in order to compare with other groups and other students. Once this is calculated and is graphically displayed it will allow us to establish the degree of consistency or variability (through visual and statistical analysis of "bounce") from one equivalent measure to the next.

Data Analysis

Research Question One: *Based upon pre-post testing which of these two interventions, small group instruction emphasizing, (a) vocabulary enrichment with manipulatives or (b) vocabulary enrichment with visual cues, conducted four days a week for five weeks, improve Hispanic English language learner (ELL) learner's mastery of mathematical concepts in operation and problem solving, when compared to their peers in the comparison group?*

A mixed ANOVA (repeated measures, with a grouping factor) was used as the analysis, with instructional group as the grouping factor, and pre/post assessment of math the repeated measure. This analysis was repeated for grade levels three and four. The source of data for the ANOVA was one nominal, categorical grouping variable, with three levels which are: manipulative, visual cues, and the comparison group. The ANOVA also used one continuous, equal-interval math score variable, with 2 levels, pre and post. The total N for the study included forty-eight third and fourth grade bilingual students together who were assigned to four bilingual teachers. Each ANOVA had six cells, which will yield a cell size of eight.

Research Question Two: When compared to their peers in the comparison group, to what degree did Hispanic English language learner's (ELL) mastery of mathematical concepts in operation and problem solving improve?

A trend analysis for the three separate groups was conducted to see growth over time. The six probes were used to compare each group for growth and improvement. The time series variable used the equal-interval scale, as the probes were administered at the same time every week. Trend analyses was conducted for each individual student, and then averaged for each group. Statistical differences between the group trend coefficients were conducted. There will be a total of 18 cells, which yield an average cell size of approximately two.

CHAPTER IV

RESULTS

This chapter presents the results that respond to the two research questions:

1. Based upon pre-post testing, which of two small-group interventions, emphasizing, a) Manipulatives or b) Visual Cues (and both emphasizing vocabulary enrichment) conducted four days a week for five weeks, most improves Hispanic English language learners' mastery of mathematical concepts in operation and problem solving, compared to their peers in the comparison group?
2. Based on progress monitoring probes, when compared to their peers in the comparison group, to what degree did members of the two experimental groups improve in mastery of mathematical concepts in operation and problem solving?

This study assessed the effects of two instructional strategies, both involving explicit vocabulary enrichment: manipulative-based instruction; and visual cues in mathematics, conducted in a small group setting with twenty-four 3rd grade and twenty-four 4th grade bilingual, Hispanic students who are English language learner's (ELL). The study used two sets of instruments: a) a pre/post math assessment derived from the 1999-2002 TAAS release tests; and

b) a series of 4 math mini-probes, following the pre-assessment and preceding the post-assessment. The assessment items in the pre- and post-assessment were taken directly from the original test items in the 3rd and 4th grade TAAS tests administered in the spring of 1999-2002. A committee of mathematics specialists and teachers selected the items for the assessment. The items represented those objectives which most readily lend themselves to working with manipulatives and visual cues in mathematics instruction. Each of the selected objectives was represented by two word problems on the test; thus there were a total of twenty items. The mini-probes contained twelve word problems that assessed four objectives of the 1999-2002 TAAS 3rd and 4th grade mathematics release tests. The released TAAS tests did not provide enough sample items to compile the four mini-probes, so additional items were created with minor changes, e.g. to the name of the person and the quantities in the word problem. The four equivalent mini-probes measured weekly improvement throughout the study.

Descriptive Information on the 3rd and 4th Grade Study Participants

Table 4 shows descriptive information for the twenty-four 3rd grade participants to include the following: a) gender, b) Oral Language Proficiency Test (OLPT); and c) home language.

Table 4

Descriptive Information for the Third Grade Participants. Information Includes the Following: a) Gender, b) OLPT; and c) Home Language.

Group	**Gender**	**OLPT**	**Home Language**
Manipulatives N=8	Male 4	[a]NES 0 [b]LES 1 [c]FES 3	English 0
	Female 4	[a]NES 0 [b]LES 3 [c]FES 1	Spanish 8
Visual Cues N=8	Male 3	[a]NES 1 [b]LES 2 [c]FES 0	English 0
	Female 5	[a]NES 2 [b]LES 1 [c]FES 2	Spanish 8
Comparison Group N=8	Male 4	[a]NES 1 [b]LES 1 [c]FES 2	English 0
	Female 4	[a]NES 1 [b]LES 1 [c]FES 2	Spanish 8

[a] Non English Speaker
[b] Limited English Speaker
[c] Fluent English Speaker

Table 4 shows that of the twenty-four 3rd grade students who participated in the study: eleven male and thirteen female. The majority of the students in the 3rd grade were at least limited English speakers and the greatest number was fluent English speakers. This was true for both male and female students. All students had a home language of Spanish which indicated that the primary source of their level of English proficiency was school and/or peers. All students qualified for free and reduced lunch, which also labels them economically disadvantaged.

Table 5 shows descriptive information for the twenty-four 4th grade participants to include the following: a) gender, b) Oral Language Proficiency Test (OLPT); and c) home language.

Table 5

Descriptive Information for the Fourth Grade Participants. Information Includes the Following: a) Gender, b) OLPT); and c) Home language.

Group	**Gender**	**OLPT**	**Home Language**
Manipulatives N=8	Male 5	[a]NES 1 [b]LES 3 [c]FES 1	English 0
	Female 3	[a]NES 0 [b]LES 1 [c]FES 2	Spanish 8
Visual Cues N=8	Male 2	[a]NES 1 [b]LES 1 [c]FES 0	English 0
	Female 6	[a]NES 1 [b]LES 2 [c]FES 3	Spanish 8
Comparison Group N=8	Male 6	[a]NES 2 [b]LES 2 [c]FES 2	English 0
	Female 2	[a]NES 0 [b]LES 1 [c]FES 1	Spanish 8

[a] Non English Speaker
[b] Limited English Speaker
[c]Fluent English Speaker

Table 5 shows that a total of twenty-four 4th grade students participated in the study: thirteen males and eleven females. The home language for all 4th grade participants was Spanish. Most had been in the country for more than three years and did not qualify as recent immigrants; only five of the participants were recent immigrants. The majority of the students were limited English speakers, with a small group of non English speakers and an equal number of fluent English speakers. All students qualified for free and reduced lunch, which also labeled them economically disadvantaged.

Table 6 shows descriptive information for 3rd grade participant students' general school performance based on a) report card grades; b) TAAS Mathematics performance, and c) attendance records.

Table 6

Descriptive Information for Third Grade Participant Students' General School Performance. Based on a) Report Card Grades, Texas Assessment of Knowledge and Skills (TAKS) Mathematics performance, and c) Attendance Records.

Group	Grades	TAKS Results: Students who did not master all objectives**		TAKS Results: mastered all objectives	Not tested on TAKS	2+ absences
		Failed	Passed			
Manipulatives N=8	[a]Above Avg. 2 [b]Avg. 4 [c]Below Avg. 2	2	4	1	1	0
Visual cues N = 8	Above Avg. 2 Avg. 4 Below Avg. 2	0	6	1	1	0
Comparison N = 8	Above Avg. 1 Avg. 6 Below Avg. 1	0	6	0	2	0

[a]Above Average: students with a grade of 80%+ based on 9 weeks report card grade
[b]Average: students with a grade of 70 to 79% based on 9 weeks report card grade
[c]Below Average: students with a grade below 70% based on 9 weeks report card grade
** Students may pass the test with minimal scores and not have mastered all objectives; they will need accelerated instruction before taking the 4th grade TAKS Mathematics test next year.

Table 6 shows descriptive information for the 3rd grade students' general academic performance based on the average yearly report card grades, TAKS (Texas Assessment Knowledge and Skills) mathematic performance, and attendance. In the Manipulatives group, four students passed the TAKS mathematics test without mastering all objectives. They showed minimally necessary skills in 3rd grade mathematics but will need accelerated instruction to pass the next level of testing (i.e. the 4th grade test in the next year). The two students who failed mastered none of the objectives and did not meet minimal requirements on a sufficient number of the objectives to pass. Similarly, in the Visual Cues and Comparison groups, six students passed the test with minimal requirements and no mastery of the objectives.

The grades are reflective of student general yearly performance in the core subject areas: math, science, social studies, and language arts. Prior to the end of the school year, in April, the TAKS was administered to all eligible students—those who met Texas Education Agency requirements of three or more years of residence in the United States and had attended school in their country of origin. The majority of the students, sixteen, passed the mathematics portion of the TAKS with the minimum requirement, two of the students did not pass, only two mastered all objectives, two (recent immigrants) were exempt from taking the test based on their limited time in the United States, and two others withdrew from school before the test was administered.

The State Board of Education established a two-year phase-in period for students to meet a recommended passing standard. They followed the national Technical Advisory Committee's recommendation to use the standard error of measurement (SEM) statistic to determine the standards during the phase-in period. For 2003, the passing standard was set at 2 SEM below the panel recommendation, moving up to 1 SEM below for 2004 and to panel recommendation for 2005. The students in this study “passed TAKS” at 2 SEM below the panel recommended performance standard. Had the standard for 2003 been at panel recommended level, the majority of the students would have failed the 3rd test in mathematics.

Table 7 shows descriptive information for 4th grade participant students’ general school performance based on a) report card grades; b) TAAS Mathematics performance, and c) attendance records.

Table 7

Descriptive Information for Fourth Grade Participant Students’ General School Performance. Information Based on a) Report Card Grades; b) TAAS Mathematics Performance, and c) attendance records.

		TAKS Results: Students who did not master all objectives**		TAKS Results: mastered all objectives	Not tested on TAKS	2+ absences
Group	Grades	Failed	Passed			
Manipulatives N=8	[a]Above Avg. 1 [b]Avg. 2 [c]Below Avg. 5	2	5	0	1	0
Visual cues N = 8	Above Avg. 0 Avg. 2 Below Avg. 6	2	4	1	1	0
Comparison N = 9	Above Avg. 2 Avg. 4 Below Avg.2	0	7	1	0	0

[a]Above Average: students with a grade of 80%+ based on 9 weeks report card grade
[b]Average: students with a grade of 70 to 79% based on 9 weeks report card grade
[c]Below Average: students with a grade below 70% based on 9 weeks report card grade
** Students may pass the test with minimal scores and not have mastered all objectives; they will need accelerated instruction before taking the 5th grade TAKS Mathematics test next year.

Table 7 shows descriptive information for the 4th grade students' general academic performance based on the average yearly report card grades, TAKS (Texas Assessment Knowledge and Skills) mathematic performance, and attendance. In the Manipulatives group, five students passed the TAKS mathematics test without mastering all objectives. They showed minimally necessary skills in 4th grade mathematics but will need accelerated instruction pass the next level of testing (i.e. the 5th grade test in the next year). The two students in the Manipulatives group mastered none of the objectives and did not meet minimal requirements on a sufficient number of the objectives to pass. Similarly in the Visual Cues group four students passed with minimal skills and two did not meet even that level. In the Comparison group 7 passed with minimal skills but demonstrated no mastery of the objectives. There was an overall below average level of academic and particularly mathematic performance for all participants.

The grades are reflective of student general yearly performance in the core subject areas: math, science, social studies, and language arts. These students were tested under the same requirements as the third grade group. The majority of the students, fourteen, passed the mathematics portion of the TAKS with the minimum requirement, four of the students did not pass, only two mastered all objectives, and four were exempt from taking the test based on their limited time in the United States. As with their third grade counterparts, these students passed only because the phase-in allowed for 2 SEM below the panel recommended passing standard.

Descriptive Results of the Pre-Assessment Mathematic Performance

The pre-assessment was composed of ten of the thirteen TAAS objectives, pre-selected for their potential relationship to manipulative based instruction and/or visual cues. Two questions were used for each objective, for a total of twenty. The pre-assessment was given in both English and Spanish to all available 3rd and 4th grade students so that the researcher could identify those students with low mathematical skills, whether they were English or Spanish speakers, and which objectives should be included in the study. The Pre-assessment also served as the first in the series of six probes for all students in both grades.

Students were divided into two groups; third and fourth grade, with thirty-two students in each group. The researcher first read each question to the 3rd grade students in English. Students were allowed three to four minutes to complete the answer. Then the researcher read the next question in English. When the students had completed the English version of the pre-assessment, the questions were read aloud again, this time in Spanish, and the same procedures for answering were followed. Both languages were used to rule out language as a barrier to performance and measure only the mathematical skills of the students. Students responded in writing using a supply-type response format which required that they create rather than choose an answer, and show their work for solving the problem. The same set of procedures was used for the 4th grade group.

An informal item analysis of the ten objectives in the pre-assessment identified four objectives on which the students scored lowest and which were to be used as the basis of further instruction and assessment. The student population for further study was selected by limiting to those of the original sixty-four achieving <55% overall on the pre-assessment.

Table 8 illustrates the Quantile distribution of student performance on the pre-assessment based on a) all available students; b) all available 3rd grade students; c) all available 4th grade students; d) 3rd grade students identified to participate in the study; e) 4th grade students identified to participate in the study; and f) all students assigned to the control group.

Table 8

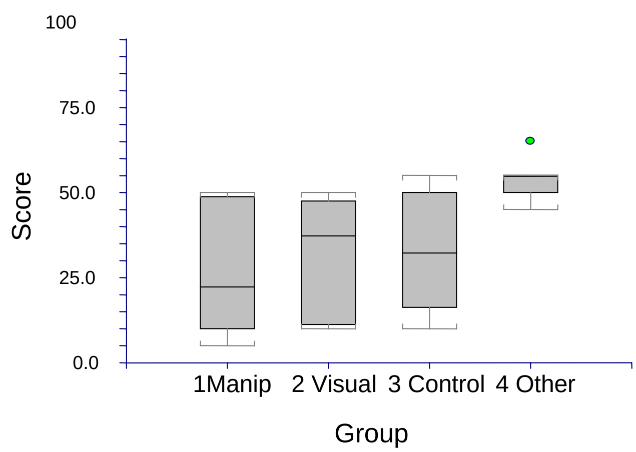
Quantile Distribution Table Showing Percent of Students Scoring in Each Quartile of the Pre-Assessment. Data based on a) All Available Students; b) All Available 3rd Grade Students; c) All Available 4th Grade Students; d) 3rd Grade Students Identified to Participate in the Study; e) 4th Grade Students Identified to Participate in the Study; and f) all Students Assigned to the Control Group.

All Groups	Percentile				
	10th	25th	50th	75th	90th
All Students[a] (N=64)	10	20	35	50	55
3rd Grade Students (N=32)	10	15	42.5	50	55
4th Grade Students (N=32)	6.5	21.25	35	45	55
3rd Grade Participants (N=24)	10	11.25	32.5	50	50
Manipulatives (N=8)	5	10	22.5	48.75	50
Visual Cues (N=8)	10	11.25	37.5	47.5	50
Comparison (N=8)	10	16.25	32.5	50	55
4th Grade Participants (N=24)	5	16.25	27.5	38.75	45
Manipulatives (N=8)	5	7.5	22.5	37.5	45
Visual Cues (N=8)	5	21.25	30	35	45
Comparison (N=8)	10	17.5	32.5	40	45

Table 8 shows that for performance of all sixty-four students on the pre-assessment, 90% answered fewer than 67.5% of the questions correctly, which was below the usually accepted passing average of 70%.The median score for all students was 37.5%. The participating 3rd and 4th grade students were selected based upon those of the original sixty four who scored <55% overall on the pre-assessment.

Figure 1 shows a box plot for all 3rd grade students and their success on the pre-assessment, calculated from only the ten pre-selected objectives (20 questions) from the 1999-2002 released TAAS mathematics tests for 3rd grade. The scores were calculated as a percentage correct out of twenty questions. The students who scored lowest on all ten objectives were identified to form the experimental groups (Manipulative, Visual Cue, and Comparison) to receive supplemental small group math instruction twenty-four minutes a day, four days a week for five weeks.

Figure 1. Box Plots of Pre-Assessment Results for All Thirty-two Third Grade Students by Group. The groups are as following: Manipulative (N=8), Visual Cues (N=8),, Control Group (N=8),, and d) Other (N=8). Students who were used Only as a Second, Separate Comparison Group in order to Compare Averages. Box Plots of All Students in their Designated Groups



The above figure illustrates percentile distributions for pre-assessment results for 3rd grade groups: Manipulative, Visual, Comparison, and Other group**.** The box plot labeled

"Other" are the students who did not qualify for the study based on the maximum score limit of 55. All three participant groups are similar, with interquartile ranges (IQR) no higher than 55. In the Other group, composed of those who did not receive an intervention, the scores are between 55 and 75.

Figure 2 shows a box plot for pre-assessment scores of all 4th grade students using only the ten pre-selected objectives (20 questions) from the 1999-2002 released TAAS mathematics tests for 4th grade. The scores were calculated as a percentage correct out twenty questions. The students whose average scores were the lowest on all ten objectives were identified to become members of treatment groups and receive supplemental small group math instruction twenty-five minutes a day, four days a week for five weeks. In order to improve logical inferences from the results, equivalent groups were formed by matching the pretest results, from the randomized student lists. Randomization with post-matching for balance is superior to pure randomization with small numbers of subjects. Students with similar scores were matched and then randomly reassigned to treatment groups to make the groups as equivalent as possible.

Figure 2. Box Plots of Pre-Assessment Results Illustrating all Thirty-two Fourth Grade Students by Group. The Groups are the following: a) Manipulative, b) Visual cues, c) Control group, and d) Other. Students that were Ineligible to Participate based on their score. Box Plots of All Students in their Designated Groups. (Manipulatives N=8) (Visual N=8) (Control N=8) (Other N=8)

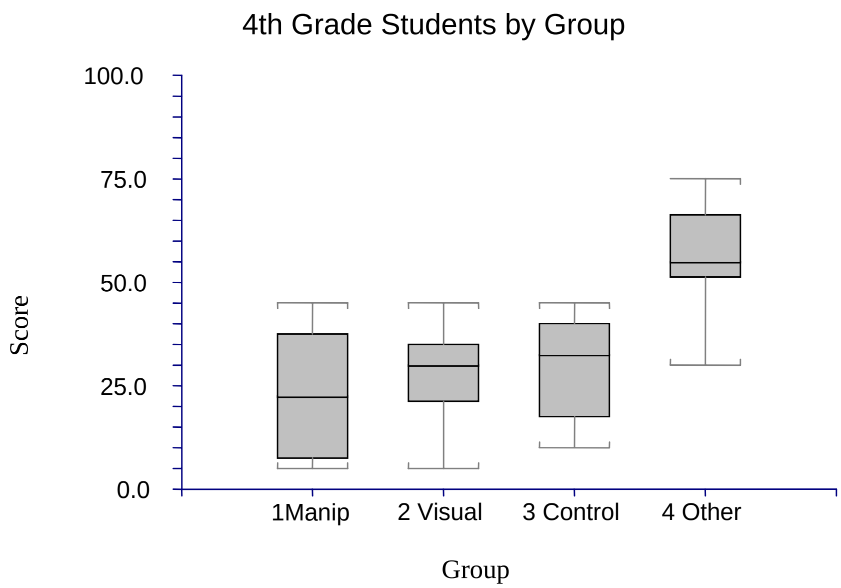


Figure 2 illustrates pre-assessment percentile distributions for 4th grade groups: Manipulative, Visual Cues, Comparison and the Other groups. All three participant groups—Manipulative, Visual Cues and Comparison— were similar with the interquartile range (IQR) no higher than a 45. In the Other group, which included only those who did not receive the interventions and were excluded from the study other than to participate in the pre and post assessment average scores were not much higher.

Table 9 shows descriptive statistics for all students for the pre-assessment: a) all available students (3rd and 4th combined), b) all available 3rd grade students, c) all available 4th grade students.

Table 9

Descriptive Statistics for All Students for the Pre-Assessment. Based on the following Information: a) all available students (3rd and 4th combined); b) all available 3rd grade students c) all available 4th grade students.

All Available Students	Pre-Assessment				
	N	Median	M	SE	SD
All Students (N=64)	64	35.000	35.200	2.300	18.040
3rd Grade Students(N=32)	32	42.500	36.250	3.230	18.310
4th Grade Students (N=32)	32	35.000	34.210	3.180	18.010

Table 9 shows the descriptive means for the pre-assessment of all available students combined and by grade level. The overall mean for all available students was 35.2% out of a possible 100%, with no notable differences between and across grade levels. Other descriptive statistics such as the standard deviation was noted between pre-assessment scores of all students, scores are consistently at the failing level.

Table 10 shows descriptive statistics for 3rd grade students for the pre-assessment a) all available 3rd grade students; b) three 3rd grade subgroups: manipulatives, visual cues, comparison, and other,

Table 10

Descriptive Statistics for Third Grade Students for the Pre-Assessment. Information on the following: a) All Available 3rd Grade Students; b) Three 3rd Grade Subgroups: Manipulatives, Visual Cues, Comparison, and Other,

	Pre-Assessment				
All 3rd Grade Participants	N	Median	M	SE	SD
3rd Grade Participants N=24)	24	32.500	30.410	3.530	17.310
Manipulatives(N=8)	8	22.500	26.870	6.800	19.260
Visual Cues(N=8)	8	37.500	31.250	6.030	17.060
Comparison(N=8)	8	32.500	33.120	6.110	17.300

Table 10 shows the descriptive means for the pre-assessment of all 3rd grade participants and the selected participants in their designated group. The overall mean for all participants was 30.4% out of a possible 100%. Equivalent ability groups based on scores were formed by randomly re-assigning students to three different instructional intervention groups: explicit vocabulary using Manipulatives, explicit vocabulary using Visual Cues and a Comparison group. Due to the small number of 3rd grade students in each intervention group the standard deviation was still relatively consistent with all participants.

Table 11 shows descriptive statistics for 4th grade students for the pre-assessment a) all 4th grade participants; b) three 4th grade subgroups: Manipulatives, Visuals Cues, and Comparison.

Table 11

Descriptive Statistics for Fourth Grade Students for the Pre-Assessment. Information of the Following: a) All Available 4th grade students; g) Three 4th Grade Subgroups: Manipulatives, Visuals Cues, and Comparison.

	Pre-Assessment				
All 4th Grade Participants	N	Median	M	SE	SD
4th Grade Participants (N=24)	24	27.500	27.080	2.650	13.010
Manipulatives(N=8)	8	22.500	23.120	5.250	14.860
Visual Cues(N=8)	8	30.000	28.120	4.320	12.220
Comparison(N=8)	8	32.500	30.000	4.430	12.530

Table 11 shows the descriptive means for the pre-assessment of all 4th grade participants and the selected participants in their designated group. The overall mean for all participants was 27.08% out of a possible 100%. The standard deviation is 13.01 meaning the range of scores was from approximately 14% to approximately 40% passing rate. Equivalent ability groups based on scores were formed by randomly re-assigning student to three different intervention instructional groups: explicit vocabulary using manipulatives, explicit vocabulary using visual cues and a comparison group. Even though there were a small number of 4th grade students in each intervention group the standard deviation were still relatively consistent across intervention groups.

Instrument Reliability for Pre/Post Assessment Instruments

A Cronbach's alpha (or coefficient alpha) is a measure of internal consistency, one important type of reliability. It is a good estimate of the reliability of the pre/post test based on its comparison with another equivalent form of the test. Alpha is the average of all possible split/half comparisons between equal item groups in the test. The pre/post tests were developed at the same time using essentially the same questions, but changed numerical representation and names in the story problems. Both tests were created to be equivalent with the same level of difficulty and format. Since Cronbach's alpha is a correlation, it can range between -1 and 1. In most cases it is positive, although negative values arise occasionally as was the result of the grade level four of this present study. According to Carmines (1990), a Cronbach's Alpha value of at least 0.8 should be achieved for widely used instruments. For experimental instruments, which are not being applied for important real-world decision-making, then .75 may be acceptable.

Furthermore, a Cronbach's Alpha is conducted on an entire test only when all items in the test measure closely related skills, as in the present study. All items in the pre/post assessment instruments were mathematical and required multi-step to solve the word problem that included division, multiplication and other basic skills. Results from the Alpha on the grade level three tests yielded a .799 and for grade level four a .711.   For an experimental test, grade three possesses reasonable reliability so it should have been reasonably sensitive to measure the improvement of participants in the present study. However, the manipulative and visual cue interventions needed to be strong and long enough.

The grade level four tests show quite low reliability (internal consistency), so it produced a weak measurement for the present study. With such weak reliability, improvement was difficult to measure. Extra time should have been spent to try out different items until the tests arrived at a higher level of reliability.

Research Question One

Based upon pre-post testing, which of these two interventions, a) Manipulatives or b) Visual Cues (both including vocabulary enrichment), conducted four days a week for five weeks, improve Hispanic English language learner's mastery of mathematical concepts in operation and problem solving, when compared to their peers in the comparison group?

To answer this question, a mixed ANOVA (repeated measures, with a grouping factor) was used, with instructional group as the grouping factor, and pre/post assessment of math the repeated measure. This analysis was conducted independently for grade levels 3 and 4. The ANOVA included a nominal, categorical instructional intervention variable, with three levels: Manipulative, Visual Cues, and the Comparison group. The ANOVA also used one continuous, equal-interval math score variable, mathematical assessments with 2 levels, pre and post. Each ANOVA had six cells, which yielded a cell size of eight.

A power analysis for the mixed ANOVA design (one repeated measure with two levels and one between-factor with three levels) was conducted. Using the significance level of .05, the power results for the design was 75% for a critical effect size of .65, and 85% for a critical effect size of d=.65. This amount of power was considered marginally adequate for the expected results.

Table 12 shows the results of the mixed ANOVA (repeated measures, with a grouping factor). The instructional group was used as a grouping factor and the pre/post assessment of mathematics as the repeated measure.

Table 12

Third Grade Analysis of Variance Table

	DF	Sum of Squares	Mean Square	F-Ratio	Prob.Level
Instructional Group	2	116.666	58.333	0.160	0.851
Pre/Post Math Test	1	8268.750	8268.750	22.810	0.000
Interaction	2	237.500	118.750	.330	.722
Error	42	15225.000	362.500		
Total(adjusted)	47	23847.920			

Table 12 shows the results of the mixed ANOVA (repeated measures, with a grouping factor) with the instructional group as a grouping factor and the pre/post assessment of math, the repeated measure. The source of data was one nominal, categorical grouping variable, with three levels which are: Manipulatives, Visual Cues, and the Comparison group. The ANOVA also used a continuous, equal interval math score variable, with two levels, pre and post assessment. The total number (N) of 3rd grade students was twenty-four. The ANOVA had six cells, which yielded a cell size of eight.

A mixed ANOVA yields the results of three main effects thus calculating three F-ratio scores: between groups; across time (pre/post); and the interaction which was a cross between the over time comparison and between group comparison. The only relevant output was the third F which was the interaction. There was not a significant difference in the means between either the instructional groups [F=.16, p value=.857] or the interaction [F=.33, p value=.722], respectively. The individual groups did not show a significant different amount of improvement between the pre- and post-assessment. There was no progress from the pre/post assessment that could be attributed to the intervention the students received in their instructional group.

Table 13 shows the third grade means and standard deviation from the ANOVA, presented by sub-groups (treatment group x test time).

Table 13

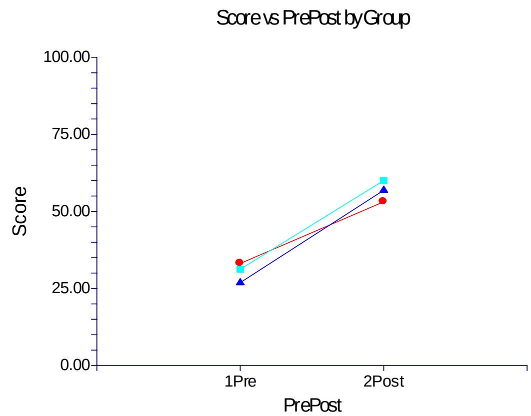
Third Grade Means and Standard Deviation from ANOVA. Information presented by sub-groups (Treatment group x Test time).

Sub Group	Count	M	SD
Manipulative Pre	8	26.875	6.731
Manipulative Post	8	56.875	6.731
Visual, Pre	8	31.250	6.731
Visual, Post	8	60.000	6.731
Comparison Pre	8	33.125	6.731
Comparison Post	8	53.125	6.731

Table 13 shows the means and standard deviations of the pre and post scores according to the different intervention group. There was improvement in the average of scores from pre- to post-assessment. The Manipulative group improved by 30 points from the pre- to the post-assessment. The Visual Cue group improved 28.75 points from the pre- to the post-assessment. The Comparison group was the least improved with the 20 points of improvement from the pre- to the post-assessment. The standard deviation was consistent throughout all the pre- and post-assessment in all three groups.

Figure 3 illustrates the interaction groups for 3rd grade. It gives a visual representation of the three instructional groups across time (pre and post assessment).

Figure 3. ANOVA Interaction Graphs for Third Grade. Instructional Group x Math Test time (pre/Post) (N=24)



The above graphs depict graphically the means table results: all three treatment groups improved over time. However, differential rates of improvement cannot be detected between the interventions.

Table 11 shows the results of the mixed ANOVA (repeated measures, with a grouping factor) for 4th grade. The instructional group will be used as a grouping factor and the pre/post assessment of mathematics as the repeated measure.

Table14

Fourth Grade Analysis of Variance Table

	DF	Sum of Squares	Mean Square	F-Ratio	Prob. Level
Instructional Group	2	396.875	198.437	0.710	0.496
Pre/Post Math Test	1	1752.083	1752.083	6.290	0.016
Interaction	2	38.541	19.270	0.070	0.933
Error	42	11693.750	278.422		
Total(adjusted)	47	13881.250			

Table 14 shows the results of the mixed ANOVA (repeated measures, with a grouping factor) with the instructional group as a grouping factor and the pre/post assessment of math, the repeated measure. The total number (N) of 4th grade students was twenty-four. The ANOVA had six cells, which yielded a cell size of eight.

A mixed ANOVA yielded the results of three main effects thus calculating three F-ratio scores: between groups; across time (pre/post); and the interaction which was a cross between the over time comparison and between group comparison. The only relevant output was the third F which was the interaction. There was not a significant difference in the means between either the instructional groups [F=.71, p value=.496] or the interaction [F=.07, p value=.933], respectively. The individual groups did not show significant different amount of improvement between the pre- and post-assessment. There was no progress from the pre/post assessment that could be attributed to the intervention the students received in their instructional group.

Table 15 shows the fourth grade means ands standard deviation from the ANOVA, presented by sub-groups (treatment group x test time).

Table 15

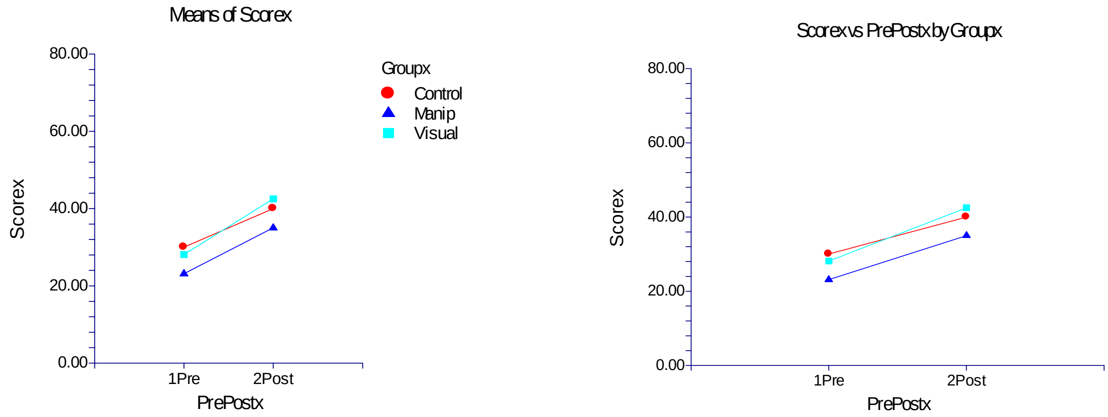
Fourth Grade Means and Standard Deviation from ANOVA. Information presented by subgroups (Treatment group x Test time).

Sub Group	Count	M	SD
Manipulative Pre	8	23.125	5.899
Manipulative Post	8	35.000	5.899
Visual, Pre	8	28.125	5.899
Visual, Post	8	42.500	5.899
Comparison Pre	8	30.000	5.899
Comparison Post	8	40.000	5.899

Table 15 shows the means and standard deviations of the pre and post scores according to the different intervention group. There was improvement in the average of scores from pre to post assessment. The Manipulative group improved by 11.88 points form the pre to the post assessment. The Visual Cue group improved 14.38 points from the pre to the post assessment. The Comparison group was the least improved with the 10 points of improvement from the pre to the post assessment. The standard deviation was consistent throughout all the pre and post assessment in all three groups.

Figure 4 illustrates the interaction groups for 4th grade. It gives a visual representation of the three instructional groups across time (pre- and post-assessment).

Figure 4. ANOVA Interaction Graphs for Fourth Grade. Instructional Group x Math Test time (Pre/Post) (N=24)



The above graphs confirm what the means table concluded: General improvement is noted across all three instructional groups. However, the improvement cannot be attributed to any particular intervention.

Research Question Two

The second research question was: When compared to their peers in the comparison group, to what degree did Hispanic English language learners improve in mathematical concepts in operation and problem solving?

To answer this question, a trend analysis for the three separate groups was conducted to evaluate growth over time, based on six sequential probes. The "Time" variable had an equal-interval scale, as probes were administered at the same time every week. Trend analyses were conducted to identify slope coefficients and their significance, for each individual student, and for group averages. There were a total of eighteen cells, which yielded an average size cell of approximately two. A trend analysis was also conducted for each individual student, and then averaged for each group. Statistical differences between the group trend coefficients were conducted.

Instrument Reliability for the Mini-Probes

Reliability in time-series is judged by how much bounce there is from one administration of mini assessment to the next. Where there is a trend, then the bounce or variability is measured around a trend line rather than around a flat mean line. A lot of bounce will yield insignificant trend lines as was the result in the present study. However, lack of significance in trend lines can also be due to very slight or small slopes (lines nearly flat), so additional information to judge significance of measurement in time series was obtained. The standard error of the slope was used as additional information. The standard error of slope was calculated by using the study's' time series data and using a regression module. Data unreliability is concluded when there are large or wide error bands around the slope. The standard error of slope is the span or interval within which there is a 68% certainty that the true slope lies, found as the SE for the raw slope coefficient. Whether a SE value is big or little can be judged by comparing the error of Slope with the slope coefficient. Typical and expected would be a standard error of about a third of the slope coefficient. A larger SE value which is close to the slope coefficient or even larger would be considered quite large, hence the time series measurement would be considered to have low reliability.

Figure 5 Third Grade Manipulatives Group

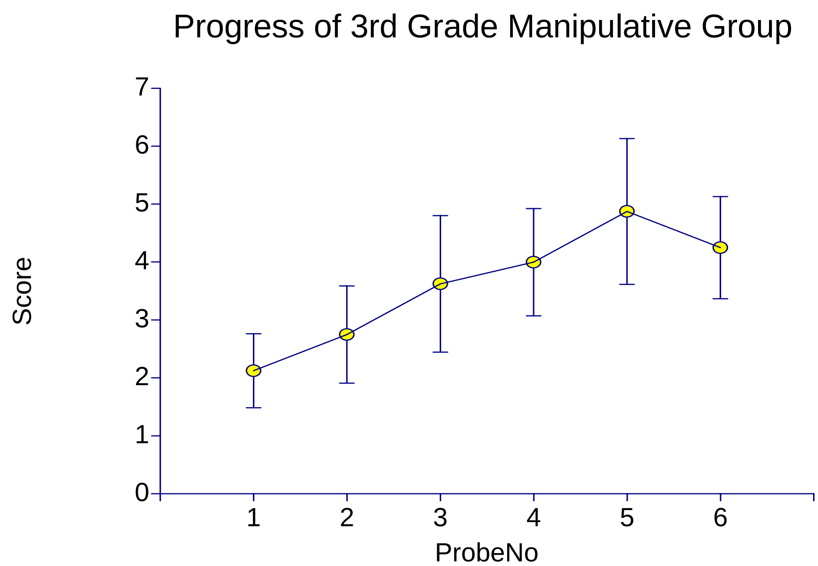


Figure 5 shows the 3rd grade Manipulative group's growth over time for six weekly mathematical probes. The probes had a maximum of twelve math items.

The circles on the graph represent the raw score means for the Manipulative group. The wands extending above and below the means are the 85% Confidence Interval (CI) for the mean, which bracket outside boundaries within which there is 85% certainty that the true mean really lies. There appeared to be a gradual improvement from the first probe through the fifth and then a decrement in the 6th probe. The slope reversed downward, from probe five to six and created a curvilinear trend. Significant improvement did occur approximately every three weeks. Overall, rate of improvement was not rapid, as between any two adjacent probes there was not a significant mean difference, as shown by overlap of adjacent confidence intervals.

Table 16

Descriptive Statistics for Third Grade Students for the Mini Probes for Third Grade Manipulatives Group

		Weekly Mini Probes					
3rd Grade Manipulatives	N	Wk 1	Wk2	Wk3	Wk4	Wk5	Wk6
M	8	2.125	2.75	3.625	4.000	4.875	4.250
SD	8	1.808	2.375	3.335	2.619	3.563	2.493

Table 16 shows the means and standard deviations for each weekly probe for the 3rd grade Manipulative group, graphed in Figure 5. There was a maximum of twelve items correct per probe. The first week the mean score was approximately 16% correct. From probe one through five there was a gradual total increase of 2 items correct. The highest average for items correct that the 3rd grade Manipulative group obtained was in week five, approximately 42% items correct overall.

Figure 6. Third Grade Visual Group

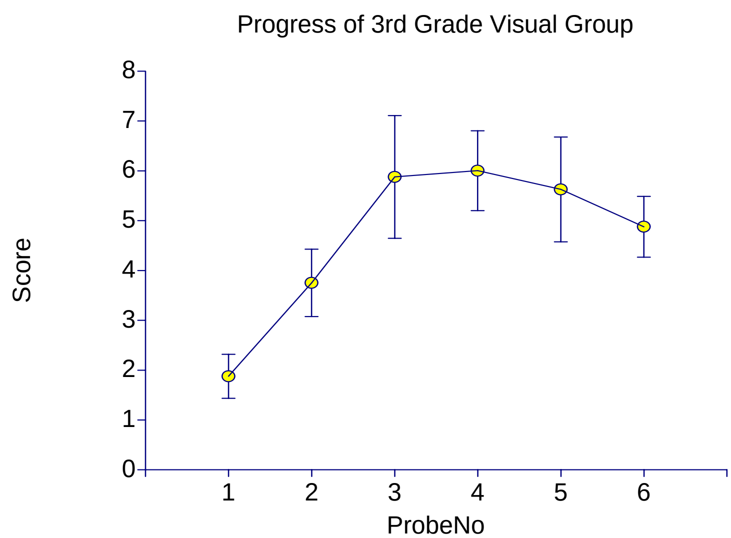


Figure 6 shows the 3rd grade Visual groups' growth over time for six weekly mathematical probes each with a maximum of twelve math items. There was a gradual improvement from the first probe through the fourth and then a slight decrement in the 5th and 6th probes. Significant improvement occurred between the first and the third probe as shown by the difference in the mean scores; also, significant improvement occurs approximately every four weeks. However, the graph line showed a curvilinear trend, due to the slope change after probe three. Overall improvement was not as large as between the first three adjacent probes; there was not a significant mean difference as shown by the confidence interval.

Table 17

Descriptive Statistics for Third Grade Students for the Mini Probes for Third Grade Visual Group.

	Weekly Mini Probes						
3rd Grade Visuals	N	Wk 1	Wk2	Wk3	Wk4	Wk5	Wk6
M	8	1.875	3.75	5.875	6.000	5.625	4.875
SD	8	1.245	1.909	3.482	2.268	2.973	1.727

Table 17 shows the means and standard deviation for each weekly probe for the 3rd grade Visual group, graphed in Figure 6. The first week the mean score was approximately 14% of items correct. From probe one through three there was a gradual increase of approximately 3 items correct, which was about a 25% improvement from one administration to another. The highest average for items correct obtained by the 3rd grade Visual group was in week four, with 6 out of 12 items or 50% correct overall. In probe five there was a decrease of .375 in the mean and in probe six a 1.125 decrease from the peak score achieved in probe four.

Figure 7. Third Grade Comparison Group

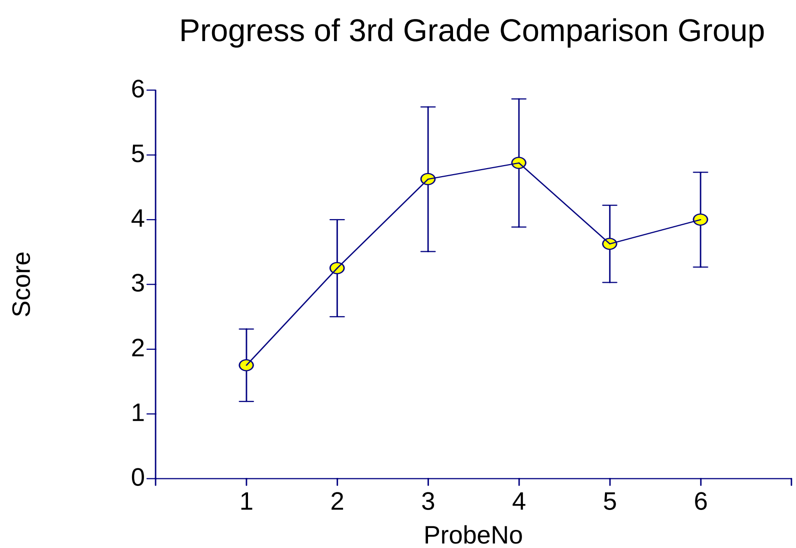


Figure 7 shows the 3rd grade Comparison groups' growth over time for six weekly mathematical probes. The line graph was curvilinear: upward from probe one through three, then a decrement after the fourth probe, and a slight increase to the sixth probe. Thus, there was inconsistent improvement from the third probe to the sixth probe. There appeared to be significant improvement between the first probe and the second probe; also, significant improvement did occur approximately every two weeks. Overall, improvement was not as large as between the first two adjacent probes and there is no significant mean difference.

Table 18

Descriptive Statistics for Third Grade Students for the Mini Probes for Third Grade Comparison Group.

	Weekly Mini Probes						
3rd Grade Comparison	N	Wk 1	Wk2	Wk3	Wk4	Wk5	Wk6
M	8	1.750	3.250	4.625	4.875	3.625	4.000
SD	8	1.581	2.121	3.160	2.800	1.685	2.070

Table 18 shows the means and standard deviations for each weekly probe for the 3rd grade Comparison group, graphed in 7. Considering the bounce that the graph shows from probe three to six, we can be quite (85%) sure, that there was consistent improvement from probe one through three. The first week's mean score was approximately 13% correct. From probe one through four there was increase of approximately 2 items correct, which was about a 16% improvement from one administration to another. The highest average for items correct that the

3rd grade Comparison group obtained was in week four, with fewer than 5 out of 12 items correct, or less than 50% of items correct overall.

Figure 8. Fourth Grade Manipulatives Group

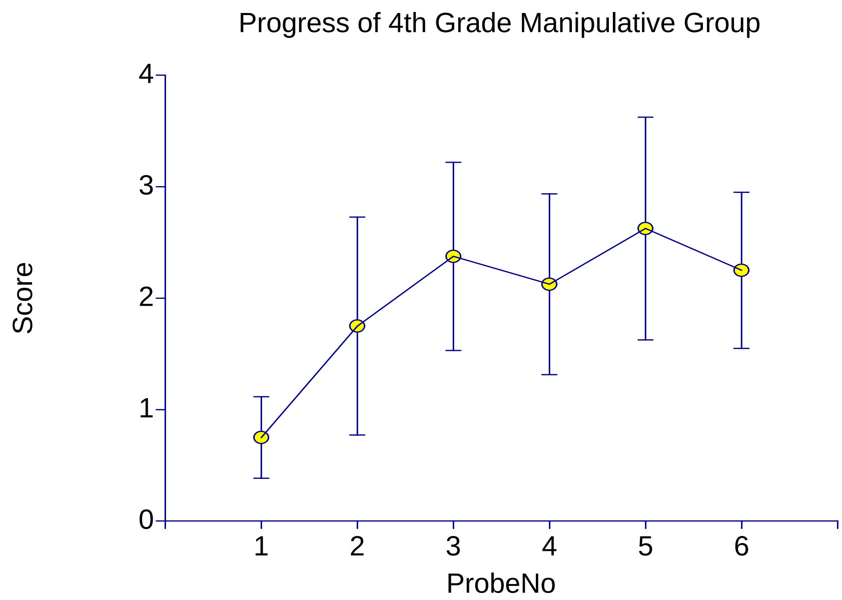


Figure 8 shows the 4th grade Manipulative group's growth over time for six weekly mathematical probes. The 4th grade manipulatives graph had a curvilinear trend. The mean of items correct shows a decrement in probe four and probe six, but overall there was an increase of two items correct throughout the five week study. The wands extending above and below the means are the 85% Confidence Interval (CI) for the mean There was a gradual improvement in means between the first and third probe and a slight decrease in the mean from the third probe to the fourth and then again from the fifth probe to the sixth. The overlap of confidence interval lines in probe two through six signifies that their means are not significantly different form one another. Overall improvement was not large; between any two adjacent probes there is not significant mean difference. Significant improvement occurred every two weeks. Where confidence intervals overlap we cannot be 85% certain that the group mean scores are really different.

Table 19

Descriptive Statistics for Fourth Grade Students for the Mini Probes for Fourth Grade Manipulatives Group.

	Weekly Mini Probes						
4th Grade Manipulatives	N	Wk 1	Wk2	Wk3	Wk4	Wk5	Wk6
M	8	.750	1.75	2.375	2.125	2.625	2.250
SD	8	1.035	2.765	2.387	2.296	2.825	1.982

Table 19 shows the means and standard deviations for each weekly probe for the 4th grade Manipulative group, graphed in Figure 8. The first week the mean score was approximately less than 8% of items correct. From probe one through three there was a gradual total increase of 2 items correct, which was about a 16% improvement from one administration to another. The highest average for items correct obtained by the 4th grade Manipulative group was in week five, with approximately 2 out of 12 items correct or 16% of items correct overall.

Figure 9.   Fourth Grade Visual Group

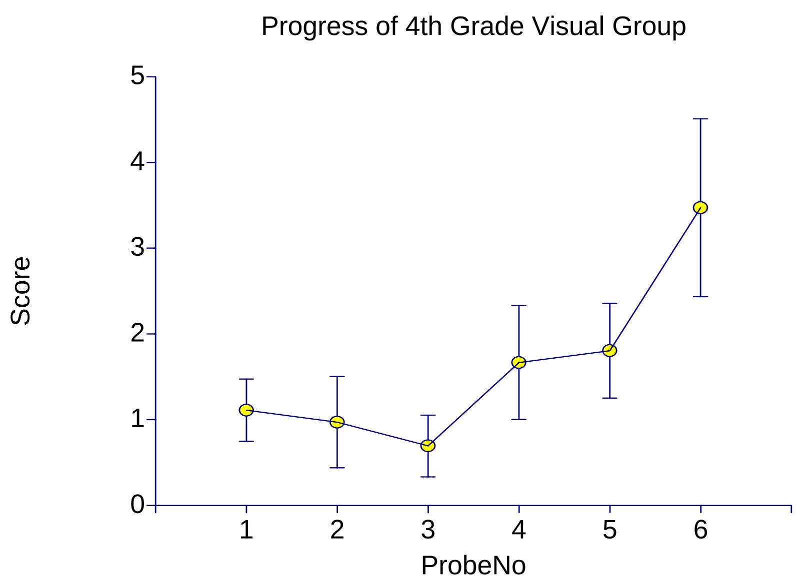


Figure 9 shows the 4th grade Visual groups' growth over time for six weekly mathematical probes. The shape of the line graph had a concave curvilinear trend that decreased between probe one and three, then increases from probe three to six. There was a gradual decrease in mean score between probes one through three. Significant improvement did occur after the third probe. Overall improvement was not as large as between any two probes adjacent to one another. There was not a significant mean difference in the mean score as shown by the confidence interval and there is overlap of confidence intervals between probe one and three and four and five.

Table 20

<u>Descriptive Statistics for Fourth Grade Students for the Mini Probes for Visual Group.</u>

	Weekly Mini Probes						
4th Grade Visuals Group	N	Wk 1	Wk2	Wk3	Wk4	Wk5	Wk6
<u>M</u>	8	1	.875	.625	1.500	1.625	3.125
SD	8	0.926	1.356	0.916	1.690	1.408	2.642

Table 20 shows the means and standard deviations for each weekly probe for the 4th grade Visual group, graphed in Figure 9. In the first week, the mean score was approximately 8% correct. From probe one through three there was a gradual decrease of approximately 2 items correct. The highest average for items correct for the 4th grade Visual group was in week six, with approximately 3 out of 12 items correct, or 25% of items correct overall.

Figure 10. Fourth Grade Comparison Group

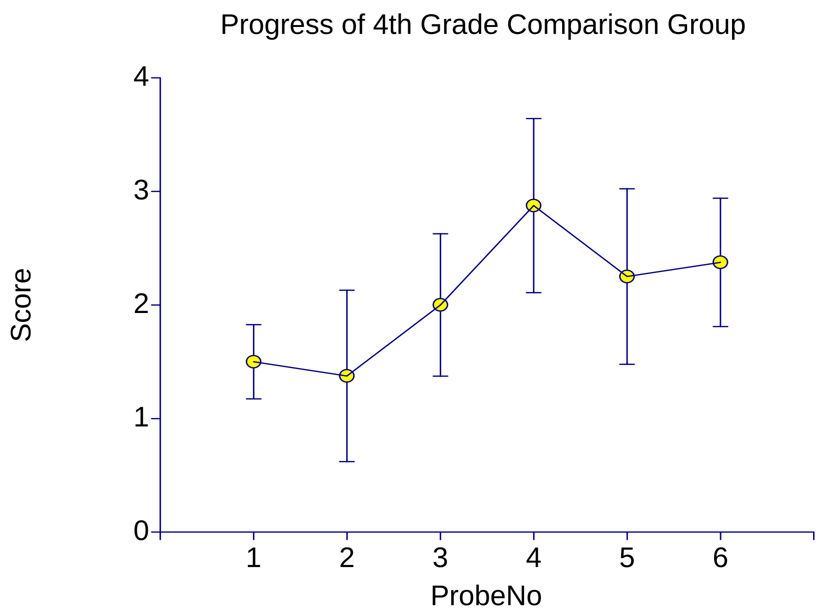


Figure 10 shows the results of the 4th grade Comparison groups' growth. The graph line had a curvilinear trend, slightly decreasing in mean of items correct from probe one to two, then increasing from two through four. Another decrease of mean improvement is from four to five. There was gradual improvement from the second probe through the fourth, a slight decrement from the first to the second probe, and another slight decrement from the fourth probe to the fifth probe. Significant improvement did occur approximately every four weeks. Overall improvement was not as large as between any two adjacent probes, and there was no significant mean difference in the score. Overlap of confidence intervals occurs from the first through the third and then again third through the sixth; thus, there is no difference in the means.

Table 21

Descriptive Statistics for Fourth Grade Students for the Mini Probes for Comparison Group.

	Weekly Mini Probes						
4th Grade Comparison Group	N	Wk 1	Wk2	Wk3	Wk4	Wk5	Wk6
M	8	1.500	1.375	2.000	2.875	2.250	2.375
SD	8	0.926	2.133	1.773	2.167	2.188	1.598

Table 21 shows the means and standard deviations for each weekly probe for the 4th grade Comparison group, graphed in Figure 10. In the first week, the mean score was approximately 12% of items correct. From probe one through two there was a slight decrease of less than 1 item correct, about an 8% decrease. The highest average for items correct obtained by the 4th grade Comparison group was in week four, with approximately 2 out of 12 items correct or16% of items correct overall.

Summary of Graphical Representation for Third Grade Manipulative, Visual and Comparison Groups

In summary, all three third grade instructional groups (Manipulative, Visual and Comparison) improved slightly over the five week duration of the study, as seen in their increasing mean scores. There was much variability, as evidenced by SE slope and by the overlapping Confidence Intervals. The improvement did not occur from one week to another, and the trend was not linear. The graphs show curvilinear trends in all 3rd grade instructional groups. In the first three administrations a slight improvement on items correct did occur but this was not maintained with each subsequent administration, occasionally there was a decrease in mean scores. The overall highest average of items correct per week in all three groups was six out of twelve possible math items on the probe

All groups show improvement in the early probes with varying degrees of decrement in the later probes. The Manipulative group shows a consistent improving trend from probe one through four with an inflection in probe five. Throughout the study the Manipulative group averaged slightly less than five items correct per probe. The Visual group also showed a consistent improvement in probes one through three then the trend line changes taking a downward direction from probe three to six. This group also had the highest items correct per weekly probe in the first three probes, averaging 6 out of 12. The Comparison group showed a significant increase from probe one to four, the trend line takes a downward direction to probe five, and then slightly increases to probe six. Similar to the Manipulative group the average items correct per week for the Comparison group was approximately 5.

Overall, according to the graphs, all the instructional groups seem to improve between the first three consecutive administrations where they show a linear trend with adjacent probes. For example, the Manipulative group has a linear trend between probe one and five, the Visual group between one and three, the Comparison group between one and four. Although they show linear trends in the graph, their maximum average for items correct per week was 6 out of 12 which occurred in the Visual group. All three groups had mean scores decrease in the later probes, mostly between probes four to six.

Summary of Graphical Representation for Fourth Grade Manipulative,

Visual and Comparison Groups

In summary, the overall improvement in all three fourth grade groups (Manipulatives, Visual, and Comparison) was minimal as seen in their mean scores. There was much variability as evidenced from the SE slope and overlapping CIs. The minimal improvement was not consistent throughout the five week duration of the study, and the trend was not linear. The graphs show curvilinear trends in all 4th grade instructional groups. Improvements on items correct per every administration of the mathematical probe were low, with the overall highest average per week in all three groups being approximately three out of the twelve possible math items.

There is no consistent pattern among all three groups across the study. The Manipulative group shows a gradual improvement in means between the first and third probe, with slight decrements in probe four and six. The Visual group had low mean scores at the beginning between probe one and three, and slightly increased their mean score between probe four and six. Their greatest improvement was at the end between probe five and six. The Comparison group shows a slight decrease in means scores in probe two, and again in probe five.

Overall according to the graphs, the Manipulative and Comparison groups seem to improve between the earlier consecutive administrations; they show a linear trend in adjacent probes. For example, the Manipulative group has a linear trend between probe one and three, the Comparison group between two and four. Although they show linear trends in the graph, their maximum average for item correct per week was less than 3 out of 12. The Visual group showed decreasing mean scores with a trend line that slightly decreased to a mean of less than 1 item correct between probe one and three. However, according to the graphs the Visual group seemed to have the most improvement between probes three and six, thus also having the highest average of items correct per week of slightly less than 4 out of 12.

Individual Slope Coefficients for Third Grade Students

Table 22 shows the raw score slope coefficient for 3rd grade Manipulative, Visual and Comparison individuals. The table contains the raw slope coefficient for every participant, interpretable as the weekly rate of linear improvement across the six mathematical probes.

Table 22

Raw Score Slope Coefficient for Third Grade Manipulative, Visual and Comparison Groups.

Manipulative		Visual		Comparison	
Slope	Signif.	Slope	Signif.	Slope	Signif
-0.143	NS	0.029	NS	-0.429	NS
0.114	NS	0.229	NS	0.029	NS
0.400	NS	0.543	NS	0.257	NS
0.486	NS	0.657	NS	0.286	NS
0.571	NS	0.686	NS	0.486	NS
0.627	NS	0.800	S	0.571	NS
0.714	S	0.800	S	0.743	S
1.200	S	1.000	S	0.943	S

Not Significant (NS) value on the table signifies that the student did not make significant improvement

As shown in Table 22 for the third grade Manipulative, Visual and Comparison groups, the raw slope coefficient is the average improvement per week. Significant tests of the trustworthiness or reliability of each slope was conducted for certainty of where the slope really lies. In order to show a wider range of improvement, a significance level of .15 was used for all three instructional groups, outlining a boundary within which exists 85% certainty that the true raw slope coefficient or rate of improvement lies.

The overall improvement of the third grade instructional groups' (Manipulatives, Visual and Comparison) raw slope coefficients was significantly small. There were eight students in every instructional group. In the Manipulative group one out of the eight students had a negative decrease in linear performance over the six probes. Two of the students showed significant improvement while the rest did not. In the Visual group all eight students show a positive improvement based on a linear trend, three participants made significant improvement and the remaining five did not. In the Comparison group, one of the eight students demonstrated an overall decrease in performance. Two of the students showed significant improvement and the rest did not. Overall there were seven out of all the participants in each group (N=24) who made significant improvement. The majority of the participants made a positive improvement but not a significant improvement.

Individual Slope CoefficientsFor Fourth Grade Students

Table 23 shows the raw score slope coefficient for 4^{th} grade Manipulative, Visual and Comparison individuals. The table contains the raw slope coefficient for every participant, interpretable as the weekly rate of linear improvement across the six mathematical probes.

Table 23

Raw Score Slope Coefficient for Fourth Grade Manipulative, Visual and Comparison Groups

Manipulative		Visual		Comparison	
Slope	Signif.	Slope	Signif.	Slope	Signif
0.057	NS	-0.229	NS	-0.229	NS
0.057	NS	0.000	NS	-0.029	NS
0.086	NS	0.086	NS	0.057	NS
0.200	NS	0.143	NS	0.171	NS
0.371	NS	0.229	NS	0.200	NS
0.457	S	0.886	S	0.257	NS
0.486	S	1.000	S	0.286	NS
0.543	S	1.029	S	1.086	S

Not Significant (NS) value on the table signifies that the student did not make significant improvement

As shown in Table 23 for the third grade Manipulative, Visual and Comparison groups, the raw slope coefficient shows the average improvement per week. Significant tests of the trustworthiness or reliability of each slope was conducted for certainty of where the slope really lies. In the Manipulative group, three of the eight participants show a significant improvement based on a linear trend, while the remaining five did not. In the Visual group one participant demonstrated an overall decrease in performance and another participant had no improvement. Three of the participants in the Visual group made significant improvement. In the Comparison group two participants demonstrated a decrease in overall performance. One of the students had significant improvement.

Most of the students' average growth per week ranges from less than 1 point to slightly above 1 point of improvement between administrations in all three instructional groups. For the majority of participants in all instructional groups, the upper and lower confidence intervals include zero, so the results were not significant, which means that the trends were not significantly different from zero; they were flat.

CHAPTER V

SUMMARY, CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

This study's purpose was to determine the improvement of third and fourth grade Hispanic English language learners' mathematical skills due to two instructional strategies, each involving explicit vocabulary enrichment—manipulative-based instruction and visual cues—conducted in a small group setting The purpose generated two research questions: 1) which daily intervention—Manipulatives or Visual Cues—would most improve low-achieving Hispanic ELL learner's math skills?; and 2) based on six progress monitoring probes, what amount and type of progress would be shown in the two experimental groups' operations and problem solving skills? The following section discusses findings from the results for these two research questions. Independent analyses were conducted for third and fourth grade levels.

The mixed ANOVA with repeated measures and grouping factors was used to compare the growth from beginning to end of the five week duration of the study. A power showed marginally adequate power for expected results, with the available sample size. Results from the pre/post test comparison of the three groups showed that no improvement could be attributed to the interventions. The third grade level's mixed ANOVA showed no significant difference in the mean scores between either the instructional groups or the interaction.

The individual instructional groups for third grade (Manipulatives, Visual Cues, and Comparison) did not show a significant improvement between the pre and post assessment. There was no progress from the pre and post assessment that could be attributed to the intervention the students received in their instructional group based on the intervention F-ratio score.

In addition, a Cronbach's alpha analysis was conducted to determine the amount of internal consistency in the pre/post assessment instruments for grades three and four. As a result, the grade three pre/post assessments yielded reasonable internal consistency (reliability). However, the grade four pre/post assessments showed low internal consistency (reliability), so it produced weak measurement of the interventions in the present study. Because of the lack of reliability of the grade four pre/post assessment instrument they were insufficiently sensitive to measure improvement.

The results of the fourth grade level's mixed ANOVA yielded a non-significant interaction (between time and instructional group). According to the findings there was not a significant difference in growth among the instructional groups. None of the instructional groups for fourth grade (Manipulatives, Visual Cues, and Comparison) showed significant improvement between the pre and post assessment. Improvement was greater in fourth grade than third grade; however, that amount of improvement could well have happened had the students remained in the classroom without receiving additional Manipulative or Visual cue instruction.

Six reasons may serve as explanation for the negative or inconclusive results for the manipulative and visual cues instruction groups. First, the duration of the study was limited to five weeks in the first semester of the school year. Had the study been conducted over a full semester, or a longer time period, students may have maintained the improvement shown at first as they became accustomed to the instructional processes. This minimal improvement was not consistent throughout the five weeks of the study and the trend lines on each instructional group were curvilinear.

In spite of the generally positive results in other studies, the present study's results are not uncommon; other inconsistencies were found in the extant research. As Thompson (1992) points out, research results concerning concrete materials vary, even among treatments that were closely controlled and monitored and that involved the same concrete material. For example, even studies by Resnick and Omanson (1987) and by Labinowicz (1985) showed little impact on children's learning using base-ten blocks. In contrast, both Hiebert and Werne (1992) reported positive results from using the same manipulative. Other studies such as Sowell (1989) concluded that "when treatments lasted a school year or longer, the result was significant: whereas, treatments of shorter duration did not produce statistically significant results" (p.502).

The second reason for the inconclusive results of the present study may be because of the particular mathematical skills that were chosen as a result of the pre-assessment. The skills were taken from TAAS which is administered at the end of the school year. Students may have had insufficient time to develop basic mathematics skills and concepts that are required for the operation and problem solving skills selected for use with the interventions in the present study. The international mathematics and science studies found a strong correlation between the student's opportunity to learn mathematical concepts and skills and the student's mathematical improvement (Husen, 1967, McKnight at al., 1987, Schmidt, McKnight, and Rizen, 1997). Furthermore, according to the Texas Education Agency's policy research report, the TAAS test was moved from fall to spring in the 1992-93 school year primarily because insufficient time was being allowed for students to develop problem solving and critical thinking skills. Since the manipulative and visual cue interventions were used during the early part of the school year, the improvement shown at the beginning of the five week study could simply be an indication of students' recovery from loss of retention over the summer break and not as a result of the interventions themselves.

The third reason for the inconclusive results for the manipulative and visual cues instruction groups may be the selection of available participants based on a mastery percentage below a fifty-five on the pre –assessment. The operation and problem solving domains in mathematics for TAAS are two of the most challenging and show a low percentage passing for all students (TEA, 2000). Therefore, the skills selected for the present study may have been too difficult for students to learn within the study's five week time frame. The mathematical operation and problem solving domains of TAAS also involve multi-step processes to solve word problems. Despite receiving manipulative and visual cue instruction, participants may have been poorly equipped to solve more complex, multi-step problems. Extant research shows that it is important to provide students the opportunity for problem solving, but opportunity alone has not been found to relate significantly to student's use of learned strategy. Therefore, if the strategy is used in isolation, students may not adequately learn how to solve non-routine or complex math problems (Waxman et al., 1998; Waxman and Knight, 1988) similar to the problems used in this present study.

The fourth reason for the inconclusive results may have been that not enough time was allotted for students to become acquainted with the manipulatives. When using concrete and visual resources, the participants seemed to lose focus on the skill to be learned and focus on the objects at hand. As a result the researcher allowed an additional five minutes each instructional session for students to become familiar with the materials that were to be used, and thus reduced the time on task during the lesson. The original plan was a greater amount of time on task so that students could process information effectively. The provision of sufficient amount of time as well as the threading of mathematics throughout an instructional day rather than only at a brief daily specified time plays a vital role in student learning. In addition to the focused time on a mathematical skill, students should have an opportunity to discuss their mathematical learning to make connections to other learning (Early Math Strategy, 2003). Carpenter, Fennema, Penelope, Chiang, and Loef (1989) found that, when instruction focuses strictly on problem solving skills, more time is needed to practice and consolidate skills, balanced with time to put those skills to use in a problem-solving context. If children memorize or simply mimic the teacher's use of the mathematical procedures without understanding, they find it difficult to go back later and build understanding (Resnick & Omanson, 1987; Wearne & Hiebert, 1988).

The fifth reason for the negative results for the manipulatives and visual cues instruction groups may have been to the lack of instrument (pre/post) reliability. Carmines (1990) suggest that as a rule, a Cronbach's Alpha value should be of at least 0.8 for widely used instruments such as the mathematical instruments used in the present study. The Alpha for grade three was .799 and the Alpha for grade four was .711, grade four yielded a lower reliability level than grade three. Because of the low reliability of the grade level four pre/post instrument, instruments will produce a weak measurement resulting in difficulty to measure improvement. The grade four tests were insufficiently sensitive to measure improvement. An increase number of items on the tests accompanied by greater internal consistency of all items would have ensured a higher reliability. More time in piloting of math items would have been necessary to achieve this. Had the duration of the study been extended or increased items in the pre/post, the level of reliability would have increased. On the other hand, grade level three pre/post assessments poses reasonable reliability, so should be reasonably sensitive to improvement. Although it possesses reasonable reliability, the elimination of bad items (items which had poor correlation with other items) would have increased reliability. Although, this method is limiting because the fewer item usually means low reliability, the pre/post assessments could have had a larger number of items, i.e. thirty or forty.

A final reason for the negative results for the manipulative and visual cues instruction groups may be the limited amount of time of the small group instructions. The lessons were developed for intervals of twenty-five minutes, four days a week; this may have been too little time of periodic instruction to develop skills and vocabulary needed to improve comprehension and skills application in such low achieving mathematical learners. Sowell (1989) performed a meta-analysis of sixty studies to examine the effectiveness of manipulatives used in mathematics over time. The consensus of these studies indicated that manipulatives can be effective; however, the long-term use of manipulatives was more effective than short-term use. In addition, Just and Carpenter (1987) found that time spent practicing a task can become one of the most important determinants of developing mathematical skills and greatly impacts the student's performance.

In summary, the most likely explanation for the small improvements in the experimental groups was the limited duration of the present study which was conducted in a pull -out setting. Five weeks was not sufficient time for students to develop the higher level thinking skills necessary to solve multi-step problems. Thomas and Collier (1997) found that, due to the lack of reinforcement in the regular classroom, skills and learning strategies learned in the small pull-out group were instructionally limiting. These higher level thinking skills for problem solving require repetitive opportunities of application for students to have a basic understanding of the mathematical concepts. Mathematics instruction for young children should be an integrated whole, rather than a series of isolated or discrete learning opportunities. Connections between topics, between mathematics and other subjects, and between mathematics and everyday life should permeate children's mathematical experiences (Clements et al., in press).

The present study's results confirm those from previous studies which examined the use of manipulatives and visual cues in mathematics instruction and indicated that they are not successful unless used well (Carpenter, Fennema, Fusson, Hiebert, Human, Murray, Oliver, & Wearne, 1994). The results obtained by the present study confirmed findings in the literature that suggest that concrete materials alone are not sufficient to guarantee success (Baroody, 1989; Fennema, 1972). Guidelines need to be established on how manipulatives should be used; teachers need to be trained in best practices for use of manipulatives. Sowell (1989) also suggested that improvement of mathematical performance occurs when the teachers are knowledgeable in their use.

In the present study the interventions using manipulatives and visual cues were well used but perhaps should have been extended. Although the interventions were used appropriately to teach the selected mathematical skills, the instructional lesson did not consistently incorporate activities that allowed students to use the manipulatives and visual cues as a thinking tool that would enable them to reflect on the mathematical concepts. As a result of the research study from the Early Math strategy report (2002), the following three guidelines were found to be effective when selecting and using manipulatives and visual cues and were used in the present study: 1) make certain that the manipulative and visualization chosen support the selected mathematics concepts to be taught, 2) have enough of the manipulatives and materials for visual cues so that all students can become active participants in the activity and, 3) provide initial opportunities for students to become familiar with the manipulatives and visual cues.

However, in the present study one important component was lacking, which was to avoid activities within the lesson that simply allow children to copy the actions of the teacher. Students may have been mimicking the teacher and memorizing the steps when the teacher was modeling the use of manipulatives and visualization cues instead of using the manipulatives and visual cues as thinking tools to enable them to process and reflect on the mathematical concept to be learned (Early Math Strategy, 2003).

Even though the present study confirms some results of other studies, it differs in three ways in terms of design: 1) inclusion of explicit vocabulary enrichment instruction for English language learners (ELL), 2) the use of the TAAS (Texas Assessment of Academic Skills) as a pre and post assessment instrument, and 3) the use of explicit lesson plans that directly targeted the mathematical skills that posed a challenge to ELL according to the pre-assessment results. Research shows that explicit vocabulary instruction for ELL is beneficial since text comprehension is a critical step in the problem solving process (Leplante, 1997). Ginsburg (1981) found that the vocabulary children have for expressing math and number concepts differs widely. In the present study, despite the attention given to the vocabulary in the word problems themselves, it was not sufficient to enable students to grasp the mathematical concepts within the problem solving process.

The use of TAAS as the assessment instrument was a positive design feature in the present study. The mathematical domains included in the TAAS are specific and designed to measure problem solving and critical thinking skills in the state curriculum (TEA, 2002). Therefore, all assessment instruments used in the present study were created from the content universe developed by TEA for the TAAS in mathematics, grades three and four. The Texas Education Agency followed a rigorous process to ensure reliability and developed a series of assessment instruments to measure student achievement.

The present study also incorporated a third design feature: explicit scripted lesson plans developed to directly target the mathematical skills that pose a challenge to ELL according to the pre-assessment results. Although the intent of the present study was to focus on the mathematical concepts in the pre-assessment with which students demonstrated a weakness and to improve their performance on those concepts, it did not allow students to interpret and apply personal experience to give meaning to the new knowledge (Stein & Bovalino, 2001). Therefore, the manipulatives and visual cues were not used as a thinking tool; rather they were utilized to recapitulate the steps and processes that were modeled by the teacher.

The second question addressed by this study was about the rate of improvement by the two experimental groups in the mathematical domains of operation and problem solving, based on six progress monitoring probes.

A trend analysis was conducted independently for third and fourth grade to determine growth over time. An individual raw slope coefficient was also conducted for third and fourth to interpret the weekly rate of linear improvement across the six mathematical probes. Results from the trend analysis showed a slight improvement of items correct per week with an occasional decrease of mean scores. However, the improvement trend lines lacked significance and deemed lack of reliability. The trend line for the third grade experimental groups was not linear; it had much bounce from one administration to the next. The overall improvement of the third grade groups' raw slope coefficients was small.

The results from the three experimental groups (Manipulative, Visual, and Comparison) showed minimal improvement in mean scores. The graphs showed curvilinear trends in all 4th grade instructional groups. According to the findings the early administration of the probes demonstrates a linear trend to the initial adjacent probes. However, results of the fourth grade level's trend analysis yielded inconsistent results. In time-series data, reliability of assessment instruments may be judged by how much bounce there is from one time to the next. Sine there was much bounce; we may be able to say that it yielded few significant trend lines, which lacked in the present study. Results from the raw slope coefficient showed a range from slight increase to a decrease for some of the participants, which indicate the trend to be insignificant the same as zero, they are flat.

Overall the results for third and fourth grade showed similar trend lines and minimal increases in mean scores. The progress from one week to another was inconsistent, due to the low reliability of the assessment instruments used in the present study.

Discussion

Five reasons may serve as explanations for the inconsistent, minimal or nonexistent improvement results that the trend analysis yielded for third and fourth grade growth across the six weekly mathematical probes. First, four days a week of instruction may have been insufficient time for students to learn new mathematical skills involving new processes, manipulatives and visual cues. Four days of instruction was probably insufficient opportunity to learn the application of manipulatives and visual cues prior to the weekly assessments. This is particularly true when students are asked to solve complex mathematical story problems. The Early Math Strategy (2003) found that in order for mathematics instruction to be meaningful students must be allowed sufficient time to practice integrated learning of manipulatives and visual cues to solve mathematical word problems. The weekly assessments were given on the fifth day after four days of instruction. The four mathematical objectives were taught sequentially with a different objective taught daily. This fragmented instructional schedule may have caused the minimal or non-existent growth across the six weekly probes. Greater growth may have occurred had one week been devoted to each objective. Garafalo and Lester (1985) explained that children's knowledge can be expanded through multiple opportunities to practice the instructional models given and although multiple opportunities to practice were given; they were not given consecutively and devoted to a single objective. Thus, the weekly grouping of all objectives rather than teaching each objective for a full week may have not allowed students to recognize and apply the skills consistently.

The second reason that may explain the inconsistent results from the third and fourth grade participants over the six weekly probes is the time of the school year during which the last three probes were administered. The last three probes were administered during the Fall season celebrations. Students may have been distracted by celebrations that were occurring in the classroom and unfocused during the lessons and furthermore rushed, through the weekly assessment. In addition, research suggests that elementary students use procedures, correctly or incorrectly, for the purpose of obtaining an answer and not for the purpose of solving a problem (Baroody, 1985). Garafalo (1985) discovered that once a student is aware of and confident in using what they consider to be a good strategy such as the use of manipulative or visual cues presented in the present study,, they are likely to use the strategy inappropriately and forego seeing if their final answer makes sense. Thus, students in this study may have been distracted unfocused, rushed and satisfied with simply finding an answer.

The third reason that may explain the inconsistent results and minimal improvement is that the participants were also undergoing additional testing required by the school district. Students may have become fatigued with the overwhelming amount of assessments being administered. The complex mathematical problem solving tasks and processes may have overwhelmed the participants and negatively impacted their performance on the weekly assessment probes. Research suggests that in the early grades testing may cause anxiety, therefore, hindering students' natural instincts for learning (Early Math Strategy, 2003).

The fourth reason that may explain the inconsistent results and minimal improvement is the amount of reliability in the time series probes was judged by how much bounce there was from one administration to another. There was much bounce in the third and fourth grade as shown by the graphic representation, which yields insignificant trend lines. However, lack of significance in trend lines can also be due to slight or small slopes (nearly flat); therefore, additional information, was used to judge significance of the measurement. The standard error of the slope was summarized by the confidence bands placed around the trend lines. Also, the time series data were calculated through a regression module which yields the standard error of the slope. Thus the mini-probes were unreliable as shown by the large or wide error bands around the slope. In the present study the standard error of the slope was large based on the comparison to the slope coefficient. Hence, the standard error of about a third of the slope coefficient or any larger standard error value which is close to the slope coefficient is quite large: the time series measurement is considered to have low reliability.

The final reason that may explain the inconsistent results is the way language may affect mathematics performance. Marked differences in English and Spanish fluency are considered a contributor to Hispanic Americans' performance and level of involvement in mathematics (Valverde, 1984). The participants in this study fall under those predicaments that are associated with ELL. Although the language of instruction was taken into consideration in the present study it may not have been enough for students with limited background knowledge to process and apply new mathematical concepts and skills.

Morgan (1998) found that students possessing linguistic skills associated with the advantage of having a literate background are more likely to display the appropriate mathematical operations than those that are from less advantaged backgrounds. Therefore, the participants in this study may have lacked high utility language related to both mathematics and thinking to enable them to perform at consistent progressing levels

Limitations of the Study

Four limitations associated with this experimental study. The first limitation was the low mathematical skill and ability levels of the participants The participants did not demonstrate the basic mathematical computation skills necessary to solve multi-step story problems requiring higher level thinking and application abilities. Since the participants selected for this study scored <55% overall on the pre-assessment, their mathematical skills and ability may have been too low for the domains of operations and problem solving and the learning and use of new processes. Students may have needed more time to learn the process of effectively using manipulatives and visual cues to solve mathematical word problem.

The second limitation may have been the five week duration of the present study. If extended, the duration may have made a difference in the inconsistent and negative results. Although the graphs of the trend analysis showed linear trend lines with the initial administration of the mini-probes, the duration of the study was too short to determine if sustained improvement would have occurred. Perhaps, if the study had been conducted over a one year period like Sowell (1989) suggests, the results would have been more consistent and students may have maintained the improvement shown at the beginning.

The third limitation may have been the twenty-five minute four days a week instructional small group sessions. The sessions may have been too short a period of instruction for low achieving mathematical learners' to develop skills and vocabulary necessary to improve comprehension and skills application. Should the length of instruction be extended to forty-five minutes a day four days a week, students would have the opportunity to discuss and apply the new learning strategy with manipulatives and visual cues.

The fourth limitation in the present study was the reliability of both pre/post assessments and the multiple probes. A Cronbach's alpha analysis was conducted to determine the amount on internal consistency in the pre/post assessment instruments for grades three and four. As a result, the grade four pre/post assessments showed low internal consistency (reliability) and grade three pre/post assessments yielded reasonable internal consistency (reliability). Therefore, had the duration of the study been extended or more items in the pre/post the level of reliability would have increased. In addition, an increase number of items on the tests accompanied by greater internal consistency of all items would have ensured a higher reliability, which also meant more time to test additional items.

Lack of reliability in the mini-probes was a potential reason for inconsistent results. The amount of reliability in the time series probes was judged by how much bounce there was from one administration to another. There was much bounce in the third and fourth grade as shown by the graphic representation, which yields insignificant trend lines. However, lack of significance in trend lines can also be due to slight or small slopes (nearly flat); therefore, additional information, was used to judge significance of the measurement. The mini-probes were unreliable as shown by the large or wide error bands around the slope. In the present study the standard error of the slope was large based on the comparison to the slope coefficient.

Implications for Future Research

Given the inconsistent or negative results obtained by this study, the question still remains whether manipulative and visual cues improve the third and fourth grade Hispanic English language learners' mathematical skills. While effective instructional strategies to improve mathematical skills for Hispanic ELL utilizing manipulative and visual cues would certainly be an ideal goal to achieve, evidence from the present study suggests that there is still much to learn about using such interventions. In fact earlier studies concur that, regardless of the innate appeal of manipulatives and visual cues as instructional strategies, their effectiveness may produce inconsistent and negative results (Benarz & Janvier, 1998; Bughardt, 1992; Hiebert, Wearne, & Taber, 1991; Thompson, J., 1992). In addition, manipulatives have been found to poses dubious value in teaching computational skills especially for more complex problems (Kuchemann, 1981).

Mixed results from other studies suggest that manipulatives and visual cues can improve mathematic achievement when they are used with activity based mathematics learning (Suydam & Higgins, 1977). However, future research efforts would need to be structured differently from the present study in order to address this study's questions.

A recommended modification for future research is the way in which the interventions in the present study were used. The manipulatives and visual cues strategies needed to be used as a tool rather than a procedure. This would allow students to create situations that enhance the use of manipulatives and visual cues to solve complex word problems instead of replicating the procedure or process that is necessary when answering mathematical questions that allow for alternative processes.

Another recommended modification for future research would be the selection of participants. In the present study the participants scored below 55% overall in the pre-assessment which indicated very low levels of basic mathematical skills. Friedman (1978) found the effectiveness of manipulatives or visual cues in teaching children in fourth grade or below to be of little or no benefit when teaching them computational skills such as multiplication. Therefore, participants would need to be selected on the bases of having a basic understanding of math facts and computational processes necessary for multi-step mathematical problem solving that require higher level of thinking skills. In addition to the pre-assessment scores to determine participation in the present study, teacher input regarding instructional math level and attitudes about math could also used in selecting participants.

Another recommended modification for future research is the design of the present study. Although having a pre/post with time series design is one of the most effective to obtain strong internal validity, the length of time and the intervals of assessment need to be restructured. The duration of the study could be extended for ten weeks or longer. The weekly assessments would also need to be extended for administration every two weeks instead of every week. According to the analysis of regression conducted over time with the weekly mini probes, two weeks would have been a better time frame for students to apply what they have learned especially when new processes are to be learned.

A further modification in the instructional component of the study would be to focus on each learning objective independently rather than in groups. Thus, the students could learn prerequisite skills before moving on to the next sequential objective. This would also yield information through assessment as to which objectives were truly mastered.

A final recommended modification would be an extended daily instructional time from twenty-five minutes four days a week to forty-five minutes with nine instructional sessions before an assessment. This would have allowed students to interact and discuss how manipulatives and visual cues helped them solve the problems. It would also provide immediate feedback for the researcher to make observation on metacognitive process which could have been addressed in the next session. Sowell (1989) found that long-term use of manipulatives was more effective than short-term use.

Conclusion

The results from the present study confirmed findings in the literature suggesting that concrete materials alone are not sufficient to guarantee success (Baroody, 1989). The Manipulative, Visual Cue and Comparison groups did not show a significant improvement between the pre- and post-assessment. Contrary to expectations and predictions, this study's manipulative and visual cue instruction had no significant relation to skill improvement for the ELL. This study thus concurs with other research which has shown that, regardless of the innate appeal of manipulatives, their effectiveness may produce mixed results (Benarz & Janvier, 1998; Bughardt, 1992; Hiebert, Wearne, & Taber, 1991; Thompson, J., 1992).

Two types of analysis were conducted in the present study: a mixed ANOVA to measure pre-post improvement, and the regression analysis to measure improvement over several probes. Furthermore, the reliability of the instruments used was not consistent for both grade levels. The grade four pre/post assessments had low reliability, so the interventions could not be accurately measured. Although the pre-post time series design has strong internal validity it did not provide positive results for the experimental interventions. The time series analyses concurred that the third grade instructional groups improved slightly as seen in their mean scores. However, the improvement did not occur from one week to another and the trend was not linear. The most likely reasons for the limited improvement by the experimental groups were: the four days a week of instruction may not have been sufficient time, the holiday time of the year when the study was conducted; the low reliability of grade four pre/post, additional mathematical testing that was being administered by the school district, and finally the language barrier that students encountered.

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APPENDICES

APPENDIX A

3rd Grade Post Assessment Form A Spanish

1. Observa la figura. ¿Cuantas caras tiene la figura?

2. Margie y 4 amigas se repartieron en partes iguales 30 conchas que tenían. Exactamente, ¿cuantas conchas le tocaron a cada una?

3. Observa el dibujo del prisma triangulo. ¿Cuantas aristas tiene el prisma triangulo?

4. Lori tenía 16 monedas. Las dividió en 4 grupos iguales. ¿Cuántas monedas había en cada grupo?

5. Aproximadamente, ¿Qué hora muestra el reloj?

6. Peggy vendió 26 boletos para la obra de teatro de la escuela. Raymond vendio72 boletos. ¿Cuál es la mejor estimación de cuantos boletos mas vendió Raymond que Peggy?

7. ¿Qué punto en la recta numérica representa al 33?

8. Miguel entrega 125 cada día de lunes a sábado. Los domingos entrega 286 periódicos. ¿Cuál es la mejor estimación de cuantos periódicos mas entrega Miguel el domingo que cualquier otro día de la semana?

9. El lunes Julia puso 25 centavos en su alcancía. Al día siguiente puso 36 centavos en su alcancía. ¿Cuánto dinero puso en su alcancía esos 2 días?

10. Martín tiene una colección de 332 monedas. Tiene 183 de las monedas en una lata y 60 de las monedas en una taza. El resto de las monedas están en una alcancía. ¿Cuántas monedas hay en la alcancía?

11. En un cine se vendieron 204 boletos para la primera función de una película, 38 boletos para la segunda función, y 191 boletos para la tercera. ¿Cuál fue el número total de los boletos que se vendieron?

12. Josué tenía 5 globos. Compro 3 globos más. Después se le fue 1 globo. ¿Cuántos globos tiene Josué ahora?

13. Francisco tiene 376 monedas en una caja. Tomo 197 monedas y las gasto. ¿Cuántas monedas le quedaron a Francisco en la caja?

14. El anuncio muestra los precios de la comida en un juego de béisbol. ¿Cuánto costarían un hot dog y unas papas fritas?

15. $$\begin{array}{r} 42 \\ \underline{-\ 20} \end{array}$$

16. El grupo de niñas exploradoras de Betty se preparo para hacer una excursión. El grupo tenia12 sándwiches para compartirlos en partes iguales entre las 6 niñas exploradoras. ¿Cuál oración numérica se puede usar para saber cuantos sándwiches le dieron a cada niña exploradora?

17. Se doblo un papel en 2 partes. José dibujo 4 estrellas en cada parte. Has un dibujo que muestra cuantas estrellas dibujo José.

18. Al comprar tomates, Janet los puso en 5 bolsas de plástico. La menor cantidad de tomates en una bolsa era de 8, y la mayor cantidad de tomates en una bolsa era de 11. ¿Cuál es un numero total razonable de tomates que compro Janet?

19. Elise tiene 7 páginas con calcomanías. Hay 12 calcomanías en cada página. ¿Qué es el número total de calcomanías en estas páginas?

20. Alfredo necesita pagar 54 centavos por un juguete. Tiene 2 monedas de 25 centavos y 2 monedas de 10 centavos. ¿Cuál grupo de monedas seria suficiente para pagar el juguete?

APPENDIX B

3rd Grade Post Assessment Form B English

1. Draw a figure that has more than 4 sides?

2. Ms. Donovan put 24 sticks of gum on her desk to use as prizes for the class spelling bee.

   If there were 6 sticks of gum in every package, how many packages did Ms. Donovan need in order to get 24 sticks of gum?

3. Which point on the number line represents 46? Mark your answer.

4. Letty and 3 friends shared 24 jelly beans. Letty put an equal number of jelly beans into 4 cups. What was the total number of jelly beans in each cup?

5. Which time is shown on the clock?

6. Kati saved $87 for a new bicycle. This amount was $25 more than her brother Joseph had saved. What is the best estimate of the amount of money that Joseph had saved?

7. Mrs. McCallen has a flower garden shaped like a rectangle.
What is the perimeter of the flower garden?

8. Devin counted the number of cars in 2 parking lots at a grocery store. The front parking lot had 96 cars. The side parking lot had 44 cars. What is the best estimate of how many more cars were in the front parking lot than were in the side parking lot?

9. Felix put 17 cans of soda in an ice chest. Jenny put 14 boxes of juice in the same ice chest. How many cans and boxes of drinks did Felix and Jenny put in the ice chest?

10. The drawing shows the path that Paul takes when he walks from his house to Larry's Grocery Store. How many blocks in all will Paul walk if he walks from his house to Larry's Grocery Store and then back to his house using the same path?

11. Oscar has 3 photograph albums with family pictures in them. The first album has 115 pictures, the second has 201 pictures, and the third has 86 pictures. What is the total number of pictures that Oscar has in the 3 albums?

12. Beverly had a roll of ribbon that was 400 feet long and another roll of ribbon that was 136 feet long. She used 25 feet of ribbon to decorate some packages. How much ribbon did she have left on the 2 rolls then?

13. On Monday 174 customers came into Corbin's Hardware Store. On Tuesday 158 customers came into the store. What is the difference in the number of customers on these 2 days?

14. Mrs. Riker picked apples from the 4 apple trees in her backyard. She put all the apples in 4 baskets, with 24 apples in each basket. What was the total number of apples Mrs. Riker picked?

15. A library has 54 videotapes that can be checked out. On Monday the librarian counted 18 videotapes still on the shelf. How many videotapes were checked out from the library?

16. Mrs. Harris raises 6 kinds of vegetables in her garden. She has 4 rows of bean plants with 8 plants in each row. What number sentence shows the total number of bean plants in Mrs. Harris's garden?

17. Ms. Garret's picture album has 4 empty pages. Each page has room for 9 pictures. How many pictures can Ms. Garret place on these 4 pages?

18. Stewart Elementary School has 5 third grade classes. The greatest number of students in a class is 21. The least number of students in a class is 15. Which could be the total number of students in the 5 third-grade classes?

19. Jackie bought 7 packages of doughnuts. Each package had 5 doughnuts. How many doughnuts did Jackie buy it all?

20. Marco weighs 77 pounds. His father weighs about 125 pounds more than Marco weighs. Which could be the number of pounds that Marco's father weighs?

APPENDIX C

4th Grade Post Assessment Form A-1

1. Look at the shape. How many faces does a rectangular prism have?

2. Danny made 82 popcorn balls for a bake sale. He put the popcorn balls into plastic bags to take to the sale. He put 4 popcorn balls into each bag. How many bags did Danny need for all his popcorn?

3. Which angle in the figure best represents a right angle?

4. A bus station has 6 rows of seats in the waiting area. Each row has the same number of seats. If there are 48 seats altogether, how many seats are in each row?

5. Mr. Parcos plans to build a pen for his cats. The rectangular pen will be 43 feet long and 23 feet wide. What will be the **perimeter** of the cat pen ?

6. The largest fish in a zoo's aquarium weighs 227 pounds. The smallest fish weighs 113 pounds. Which is the best estimate of the difference in their weights?

7. Which is the best estimate of the area of the polygon drawn on the grid?

8. A boat traveled a distance of about 26 miles each hour for 4 hours. Which is the best estimate of the total distance the boat traveled?

9. $0.8 + 0.5 =$

10. Martin played 5 games of tennis. Each game lasted the same amount of time. If all 5 games lasted a total of 1 hour and 10 minutes, how long was each game?

11. 1.28 + 0.52 =

12. Maria has a 35 page coin book. There are 20 dimes on each page. Each row on a page has 5 dimes. How many rows are on each page?

13. 1.70 + 0.35 =

14. Fanny sold 61 candy bars for her soccer team. Mark sold 2 times as many candy bars as Fanny. Which number sentence could be used to find the number of candy bars that Mark sold?

15. 1.0 – 0.2 =

16. A store clerk sold 18 sets of school uniforms on Saturday. Each uniform cost $25. Which number sentence can be used to find the total cost of the school uniforms?

17.
$$\begin{array}{r} 227 \\ \underline{\times\ 42} \end{array}$$

18. Fred runs between 6 and 10 kilometers each day that he runs. Last month Fred ran 18 days. Which could be the total number of kilometers Fred ran last month?

19. A bus has 15 rows of passenger seats. There are 5 seats in each row. How many passenger seats are on the bus?

20. Betty added 113 and 149 on her calculator. Which is a reasonable total?

APPENDIX D

4th Grade Post Assessment A-1 Spanish

1. ¿Cuantas caras tiene un prisma rectangular?

2. Daniel hizo 82 bolsas de palomitas de maíz para una fiesta de la escuela. Puso las bolsas en cajas. En cada caja puso 4 bolsas de palomitas. ¿Cuantas cajas necesita Daniel para todas las bolsas de palomitas de maíz?

3. ¿Cual ángulo de la figura representa mejor un ángulo recto?

4. Una estación de autobuses tiene 6 filas de asientos en la sala de espera. Cada fila tiene el mismo número de asientos. Si hay 48 asientos en total, ¿cuantos asientos hay en cada fila?

5. El señor Parcos piensa construir un corral para sus gatos. El corral rectángulo medirá 43 pies de largo y 23 pies de ancho. ¿Cual será el perímetro del corral para los gatos?

6. El pez mas grande en el acuario de un zoológico pesa 227 libras. El pez mas pequeño pesa 113 libras. ¿Cual es la mejor estimación de la diferencia entre sus pesos?

7. Cual es la mejor estimación del área del polígono dibujado en la cuadricula?

8. Un barco navego por 4 horas una distancia de aproximadamente 26 millas cada hora. Cual es la mejor estimación de la distancia total que el barco navego?

9. $0.8 + 0.5=$

10. Martín jugo 5 juegos de tenis. Cada juego duro la misma cantidad de tiempo. Si los 5 juegos duraron un total de 1 hora y 10 minutos, ¿Cuanto duro cada juego?

11. $1.28 + 0.52 =$

12. Maria tiene una colección de monedadas en un álbum de 35 páginas. Hay 20 monedas en cada página. En todas las páginas cada fila tiene 5 monedas. ¿Cuantas filas hay en cada página?

13. $1.70 + 0.35 =$

14. Fanny vendió 61 chocolates para su equipo de fútbol. Mark vendió 2 veces más chocolates que Fanny. Que oración numérica podría usarse para encontrar el numero de chocolates que vendió Mark?

15. 1.0 – 0.2 =

16. El empleado de una tienda vendió 18 uniformes escolares el sábado. Cada uniforme costo $35. ¿Cual oración numérica se puede usar para encontrar el costo total de los uniformes escolares?

17. $$\begin{array}{r} 227 \\ \underline{\times\ \ 42} \end{array}$$

18. Cada día que Gustavo hace ejercicio, corre entre 6 y 10 kilómetros. El mes pasado Gustavo corrió 18 días. ¿Cual podría ser el total de kilómetros que Gustavo corrió el mes pasado?

19. Un autobús tiene 15 filas de asientos para pasajeros. Hay 5 asientos en cada fila. ¿Cuantos asientos para pasajeros hay en el autobús?

20. Beatriz sumo 113 y 149 en su calculadora. ¿Cual es un total razonable?

APPENDIX E

Sample Mini-Probe

3rd Grade English

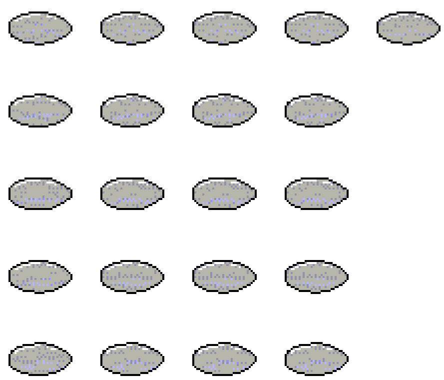
1. Doreen bought 8 small boxes of crayons. Each box had 8 crayons. What was the total number of crayons that Doreen bought? Write your answer.

2. Mr. Ferguson planted 8 rose bushes he put an equal number on each of the 2 sides of his patio. Draw a picture that shows how he divided the rose bushes.
3. A spelling book contains 88 pages. A Math book contains 203 pages. What is the best estimate of how many fewer pages the spelling book has than the Math book? Write your answer.

4. Mr. Meyer had 131 model dinosaur figures. He gave 35 of the figures to the students in his class. Then he bought 18 more figures. How many dinosaur figures did he have then? Write your answer.

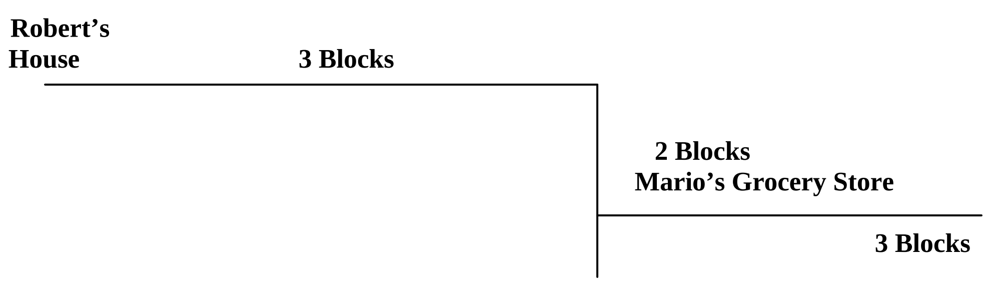
5. Ray has his baseball cards lined up on the desk. He has 8 rows of cards, with 8 cards in each row. How many cards are on the desk? Write your answer.

6. Rosalie planted 21 pumpkin seeds in 3 rows. If she planted the same number of seeds in each row, what was the total number of seeds that she planted in a row?



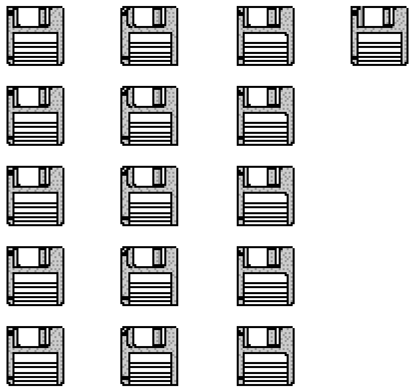
7. Mr. Grant had a roll of electrical wire that was 350 centimeters long. He used 78 centimeters to fix a lamp. Then he used 145 centimeters to place a new light switch near his desk. What was the length of wire that Mr. Grant had left on the roll?

8. The drawing shows a path that Robert takes when he walks from his house to Mario's Grocery Store. How many blocks in all will Robert walk if he walks from his house to Mario's Grocery Store and then back to his house using the same path?



9. Carlos sorted his collection of pennies into stacks of 5 pennies each. He had a total of 37 stacks of pennies. How many pennies did Carlos have in collection?
Write your answer.

10. Mr. Gonzales had 16 diskettes for his students to use. He put the same number of diskettes at each of the 4 computers in his class. How many diskettes did he put at each computer?



11. The highest point in Caldwell County is 705 feet above sea level. The lowest point is 388 feet above sea level. Which is the best estimate of the difference between the highest point and the lowest point? Write your answer.

12. Carmen had 6 balloons she bought 4 more balloons. Then two balloons flew away. How many balloons did Carmen have left? Write your answer.

APPENDIX F
Sample Mini-Probe

4th Grade Spanish

1. Un edificio de oficinas tiene 32 pisos. En cada piso hay 18 oficinas. ¿Cual es el total de oficinas en el edificio?

2. Hay 54 estudiantes en el coro. El maestro quiere organizar el coro de tal forma que haya 9 estudiantes en cada fila. ¿Cuantas filas de estudiantes habría?

3. El Sr. Martínez compro 45 racimos de plátanos para su tienda. Cada racimo tenia aproximadamente 6 plátanos. ¿Cual es la mayor estimación del número total de plátanos que el Sr. Martínez compro?

4. El Sr. López gano $15 por hacer 1 corte de pelo. Hizo 21 cortes de pelo cada semana durante las 3 últimas semanas. ¿Cuanto fue el total de dinero que gano durante las 3 semanas?

5. Un grupo de ladrillos esta ordenado en 24 niveles. Cada nivel tiene 56 ladrillos. ¿Que es el numero total de ladrillos en el grupo?

6. El Sr. Jones separo a 84 estudiantes de cuarto grado en 6 grupos. Cada grupo tenía la misma cantidad de estudiantes. ¿Cual fue la cantidad de estudiantes en cada grupo?

7. Un grupo de 68 estudiantes visito un museo. La escuela pago $4 por cada boleto de estudiante. ¿Que es la mejor estimación del dinero que la escuela pago en total para que los 68 estudiantes entraran al museo?

8. Kevin tiene una colección de monedas en un álbum de 20 páginas. Hay 30 monedas en cada página. En todas las páginas cada fila tiene 6 monedas. ¿Cuantas filas hay en cada página?

9. Julieta y su mama usaron 84 centímetros de listón para hacer 1 adorno para el cabello. Si hicieron 15 adornos, ¿Cuantos centímetros de listón usaron en total?

10. Lorenzo tiene 18 carros en su colección de carros de juguetes. Tiene los carros en exhibición en 3 estantes. Cada estante tiene el mismo número de carros. ¿Cuantos carros hay en 1 estante?

11. Abigail tenía $240 en su cuenta de ahorros. Saco $45 para gastar en un viaje al parque de diversión. Después saco $23 para pagar por algunos lentes. ¿Cuanto dinero le quedo en su cuenta de ahorros?

12. El Sr. Gómez compr0 250 sobres para enviar unas cartas de su negocio. Uso 127 sobres en marzo y 92 sobres en abril. En mayo compro 125 sobres más. ¿Cuantos sobres tenia al final?

APPENDIX G
Sample Lesson Plans

3rd Grade Manipulatives Group

MONDAY October 21, 2002	**(1) <u>Math/OBJ 8:</u>** TSW use the operation of multiplication to solve problems. **(2) <u>Group Activity:</u>** TSW take their counters and count to see how many they each have, the symbol X will be introduced as one side meaning "group" and the other meaning "of" to complete the X(times). Teacher will model two different examples. **(3) <u>Materials</u>:** colorful counters (15 each) **(4) <u>Practice Activity</u>:** TSW make "groups" "of" 2's,3's,4's and 5's with a partner
TUESDAY October 22, 2002	**(1) <u>Math/OBJ 9:</u>** TSW use the operation of division to solve problems **(2) <u>Group Activity:</u>** TSW will divide evenly into groups using their beans and counters. Teacher will model by using a story, "If I had only 21 beans, and I had 7 friends, I want to divide evenly among them: How many would each one receive… **(3) <u>Materials</u>:** Beans and counters **(4) <u>Practice Activity</u>:** TSW practice with a partner using their beans and colored counters.
WEDNESDAY October 23, 2002	**(1) <u>Math/OBJ 10:</u>** TSW estimate solutions to a problem situation. **(2) <u>Group Activity:</u>** Teacher will introduce fat belly 5 and model example by using counters and sentence strips and markers to draw hills. Teacher will tell the story and students will follow. **(3) <u>Materials</u>:** sentence strips, counters, mall number cards to place accordingly. Separate number from 1 through 20, and markers **(4) <u>Practice Activity</u>:** Students will practice independently and with a partner making their own scenarios.
THURSDAY October 24, 2002	**(1) <u>Math/OBJ 11:</u>** STW determine solution strategies and will analyze or solve problems. **(2) <u>Group Activities:</u>** Students will act out the operation of addition and subtraction. Teacher will say: "take something a way from a group" and combine 2 or more groups of things together what happens to the number of things bigger or smaller… **(3) <u>Materials</u>:** counters, students themselves **(4) <u>Practice Activity</u>:** Students will act out with a partner and in a group.
FRIDAY October 25, 2002	**Group Activity:** TSW will take the weekly assessment.

APPENDIX H

Sample Lesson Plans

4th Grade Visuals Cues and Drawing Group

MONDAY October 21, 2002	**(1) Math/OBJ 8:** TSW use the operation of multiplication to solve problems **(2) Group Activities:** TSW color the different times tables on a times table chart and skip count starting with the ones and twos together **(3) Materials:** Times table chart and pencil colors **(4) Practice Activity:** TSW completely color the times table chart a different color for every #
TUESDAY October 22, 2002	**(1) Math/OBJ 9:** TSW use the operation of division to solve problems **(2) Group Activities:** TSW color 16 squares on a grid sheet blue three times leaving room between each row of 16. The teacher will demonstrate on the overhead then color every two squares about the first row to demonstrate that there are 8 groups of two in the number 16. and continue with the 4 and the 8 **(3) Materials:** Overhead; markers and grid sheets and pencil colors **(4) Practice Activity:** TSW color 36 squares red in a row and color every four above the 36 a different color to determine how many fours are in 36.
WEDNESDAY October 23,2002	**(1) Math/OBJ 10:** TSW estimate solutions to a problem situation **(2) Group Activities:** TSW see and copy the number line on the board. The teacher will inform the students that if a number is a number in the ones place that is less than 5 it will roll back and if it is 5 or more it will spring forward in estimation. **(3) Materials:** manila paper: colors, pencil overhead, die and post it notes **(4) Practice Activity:** TSW write a number on a post it note that comes from tossing the die
THURSDAY October 24,2002	**(1) Math/OBJ 11:** TSW determine solution strategies and will analyze or solve problems **(2) Group Activities:** TSW read a story problem together with the teacher about shopping and saving. The teacher will draw a visual representation of the loss and gain of money. **(3) Materials:** manila paper; pencil & overhead **(4) Practice Activity:** TSW create their own shopping and saving problem that involves subtraction and addition.
FRIDAY October 25,2002	**(1) Math/OBJ 8,9,10,11:** **(2) Group Activities:** TSW take the mini-assessment **(3) Materials:** Mini-Assessments **(4) Practice Activity:** None

APPENDIX I

Sample Schedule

3rd Grade

Monday October 21, 2002	**Tuesday October 22, 2002**	**Wednesday October 23, 2002**	**Thursday October 24, 2002**	**Friday October 25, 2002**
Time of Pullout: 20 to 25 min.	*Time of Pullout: 20 to 25 minutes*	*Time of Pullout: 20 to 25 minutes*	*Time of Pullout: 20 to 25 minutes*	*Assessment 30 minutes*
Objective : 8	**Objective : 9**	**Objective : 10**	**Objective : 11**	**12 Questions**
Group I: Students 1.Crystal N. Miranda 2.Yesenia Aguilar 3.Jeannette Robles 4.Isamar Najar **Begin Time: ___** **End Time: ____** **<u>Absences:</u>**	**Group I: Students** 1.Crystal N. Miranda 2.Yesenia Aguilar 3.Jeannette Robles 4.Isamar Najar **Begin Time:** **End Time:** **<u>Absences:</u>**	**Group I: Students** 1.Crystal N. Miranda 2.Yesenia Aguilar 3.Jeannette Robles 4.Isamar Najar **Begin Time: _____** **End Time:** **<u>Absences:</u>**	**Group I: Students** 1.Crystal N. Miranda 2.Yesenia Aguilar 3.Jeannette Robles 4.Isamar Najar **Begin Time: ___** **End Time:** **<u>Absences:</u>**	**Students Taking** 1.Crystal N.Miranda 2.Yesenia Aguilar 3.Jeannette obles 4.Isamar Najar 5.Crystal Y. Contreras 6.Lazaro Estrada 7.Laura Reyes 8.Jesus A. Sanchez
Group II: Students Names of Student: 1.Crystal Y. Contreras 2.Lazaro Estrada 3.Laura Reyes 4.Jesus A. Sanchez **Begin Time: ______** **End Time:** **<u>Absences:</u>**	**Group II: Students** Names of Student: 1.Crystal Y. Contreras 2.Lazaro Estrada 3.Laura Reyes 4.Jesus A. Sanchez **Begin Time: ______** **End Time:** **<u>Absences:</u>**	**Group II: Students** Names of Student: 1.Crystal Y. Contreras 2.Lazaro Estrada 3.Laura Reyes 4.Jesus A. Sanchez **Begin Time: ______** **End Time:** **<u>Absences:</u>**	**Group II: Students** Names of Student: 1.Crystal Y. Contreras 2.Lazaro Estrada 3.Laura Reyes 4.Jesus A. Sanchez **Begin Time: ______** **End Time:** **<u>Absences:</u>**	**Group II: Students** 9.Argenis Garcia 10.Jasmin Espinoza 11.Lauricela Estrada 12. Jessica De Loera **<u>Absences:</u>**

Type of Instruction for Group I: Manipulatives
Type of Instruction for Group II: Drawings & Visuals
Type of Instruction for Group III: None, teacher instruction

APPENDIX J

ATTENDANCE ROSTER

Homeroom Teacher: __Bautista___ **School Year: ____2002-2003____**

Grade: Third Number of Students: 20

Week Number: ___One___ **Campus: Holleman Elementary**

Student Name	Level of English	10/21	10/22	10/23	10/24	10/25	Total
1. Yesenia Aguilar	LES						
2. Benita Armendariz	FES						
3. Crystal Y. Contreras	NES						
4. Jessica De Loera	NES						
5. Jasmin Espinoza	FES						
6. Lauricela Estrada	LES						
7. Lazaro Estrada Jr.	LES						
8. Vanessa J. Fabela	FES						
9. Argenis Garcia	NES						
10. Sonia Y. Garcia	LES						
11. Melisa S. Lozano	LES						
12. Oscar A. Martinez	FES						
13. Crystal N. Miranda	FES						
14. Isamar Najar	LES						
15. Manuel D. Ramirez	FES						
16. Laura Reyes	FES						
17. Jeanette Robles	LES						
18. Jovani Ruiz	LES						
19. Jesus Sanchez	LES						
20. Jay Taboada	LES						
21.							
22.							
23.							

- NES: Non-English Speaker, LES: Limited English Speaker, FES: Fluent English Speaker

VITA

Edith Posadas Garcia
2311 Millerton Lane
Katy, TX 77450

Experience Highlights

Waller Independent School District, Waller, Texas (1998-present)
Director, Special Populations Bilingual/ESL/Migrant/Title Programs

Region IV ESC (1998-present)
Consultant, Instructor, and Trainer

Region VI ESC (1998-2000)
Consultant and Trainer

Spring Branch Independent School District, Houston, Texas (May 1998 – Nov 1998)
Personnel Administrator

Brazosport Independent School District (1999-present)
Consultant and Trainer

Spring Branch Independent School District, Houston, Texas (Jan. 1995 – May 1998)
Teacher

Weslaco Independent School District, Weslaco, Texas (Aug. 1993 – Dec. 1994)
Bilingual Teacher

Weslaco Police Department, Weslaco, Texas (May, 1993 – Dec. 1994)
Reserve Police Officer

Education and Credentials

Aug. 2000	Texas A&M University Ph.D. Educational Psychology/Superintendent	College Station, Texas
Aug. 1997	Prairie View A&M University M.S., Education, Minor: Administration	Prairie View, Texas
May 1993	University of Texas-Pan American B.S., Education	Edinburg, Texas

Certifications

Jul. 1998	Mid-Management Certification	Prairie View A&M
May 1993	Bilingual Certification	University of Texas